INDUSTRIAL MANAGEMENT

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PREFACE TO THE THIRD EDITION

The fundamentals of management have changed little if any since the Second Edition of this book appeared in 1928. During the past decade, however, the emphasis on managerial technique has shifted considerably. It is to include these external social influences and recent trends in technical details that this revision has been undertaken.

The text is intended primarily for the college student who has had little or no industrial experience, although the essential features of the Second Edition, which has been successfully used in evening classes by hundreds of employed men and women, have been preserved. Extensive use has been made of the illustrations to enable the student to visualize more accurately the techniques and industrial situations described.

There has been no attempt to make an original contribution to the literature on management. Most of the new material of this edition has appeared in some form in management periodicals, has been presented at meetings of the professional societies, or has grown out of the authors' industrial experience. A conscious effort has been made to present what appears to the authors to be a sound philosophy of management, which may be summarized as a balanced relationship between the equities of the consumer, labor, owners of capital, management, and organized society or government. Any deviation from this approach has been a question of interpretation, not intent.

This new edition emphasizes the social and personnel aspects of industrial organization and management. A chapter has been included briefly summarizing some of the governmental influences upon management. Throughout the text the central aim has been to present a unified treatise. The technical sections of Chapters XI, XII, XIII, and XVI are presented as a matter of general information for the student; it is not expected that the average student will master these technical details.

This revision is built on the firm foundation laid by Mr. Lansburgh in his first two editions, and the privilege of using his second edition and accumulated notes is gratefully acknowledged. Professors Leon Bosch Adolph Langsner, and Arthur Bronwell of Northwestern University have made valuable suggestions concerning the arrangement of certain material. Professor Bronwell made a special contribution to Chapter XIII, "Factory Power." Mr. L. B. Cappa and Mr. R. J. Seitz of the Public

Service Company of Northern Illinois made valuable contributions to the treatment of industrial power and light. The representatives of the many industries referred to by name in the body of the text have been especially co-operative in supplying source material.

William R. Spriegel

Evanston, Illinois
July 1, 1940

PREFACE TO THE FIRST EDITION

WITH the confident judgment that in careful analysis of management problems is to be found the hope of industry, this book has been developed. Stress has been placed on general organization problems, not only in the chapters on organization, but throughout the text, with the deep conviction that if a satisfactory structure be developed for any enterprise, all other phases of management are simplified.

With the hope of stressing the fundamentals of sound management, which must be developed prior to granting attention to more spectacular phases, a number of chapters have been devoted to the background of present-day management policies, to organization as an abstract consideration, and too often-unappreciated standardization work. Throughout, the effort has been made to show the relationships of each major portion of the business to the others and the interdependence of the various major departments. Policies and principles of successful management form the background, into which are fitted the devices to carry them into effect, without which no management, however highly conceived, may be successful.

Operations have been treated with the belief that faith must be created in modern business, faith of the management in the employee, and faith of the employee in the management. They have been described with the thought that worthwhile management must be courageous, must be willing to lead, but must be always careful lest unprofitable experiments discourage future attempts to improve management methods.

The examples and illustrations have been chosen from a diverse group of industries in the hope of insuring that good management be looked upon as universally applicable. At the same time they have been chosen from the standpoint of best explaining the problem at hand. Illustrations have been taken from particular plants, wherever practicable; but necessarily, for clarity and to reach fundamentals, applications have at times been made to insure full understanding of the general principles. In the main, the text has been developed from the point of view of the medium-sized plant, but frequent reference has been made to the large and the small enterprise. Such basic principles and policies as have been laid down are applicable everywhere, and only the systems and devices which carry them into effect must be modified as the size of the plant changes.

In brief, this book aims to present a co-ordinated, simple treatment of the problems, the ideals, and the methods of successful industrial management in a way which is at the same time broad and specific, and which aims to indicate the responsibilities of the factory executives to the workers, the stockholders, and the community.

During the preparation of this book, over a period of several years, the constant help and advice of numerous industrial executives has made possible the presentation of much of the material which is included. The author wishes to express especial appreciation of the aid received from Mr. Percy S. Brown, Works Manager of the Corona Typewriter Company; Mr. George Comfort, Works Manager of the Miller Lock Company; Mr. James M. Ketch of the National Lamp Works; and Mr. H. K. Hathaway, Consulting Engineer in Management. Mr. Charles B. Gordy, Assistant Professor of Mechanical Engineering, University of Michigan, and Mr. John S. Keir, Professor of Industrial Economics, Carnegie Institute of Technology, have also rendered criticisms and comments which have materially assisted in developing the text. During the preparation of the book continual constructive comment and criticism, and, indeed suggestions for rearrangement of material, as well as much of the material itself, have been received from the following, who are or have been instructors in the Department of Industry of the Wharton School of Finance and Commerce of the University of Pennsylvania: Messrs. Robert P. Brecht, John W. Carter, Leon Henderson, Victor S. Karabasz, Francis P. O'Hara, Norris M. Perris, Theodore R. Snyder, and Morton S. Whitehill. For reading the completed manuscript and making numerous valuable comments thereon, the author is very grateful to Professor Erwin H. Schell, of the Massachusetts Institute of Technology. He wishes to express his deep appreciation of the aid received from all these sources, to which such features of this text as may be valuable are largely due.

RICHARD H. LANSBURGH.

PHILADELPHIA, PA.
July, 1923.

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INDUSTRIAL MANAGEMENT

PART I

INTRODUCTION

CHAPTER I

ADMINISTRATIVE POLICIES AND MANAGEMENT AS BUSINESS FACTORS

Management is the unseen force which drives all that is physical within a factory. It synchronizes human relationships and is by far the most vitalizing factor in our present industrial age. Machinery and materials may be put to work, workers may labor; but without adequate management to organize and consolidate them into a profitable, co-ordinate whole, to distribute the results of their work effectively, and to govern their operations during performance, this performance may become so uneconomic as to cease entirely. We are accustomed to think of the physical things: the huge plant, the wonderful machine, the useful product. We instinctively realize that some human force must have been called upon to create them, to bring them into being. But until recently, the methods of creating this force, of exercising its potentialities, were little thought of, even by those who were in daily contact with its results.

Only as the flow of commerce is interrupted by a great depression or labor disturbance, and the machinery of the plant stops, while front-page headlines in the newspapers tell us the story, do most of us inquire concerning the basic administrative and management policies of an industry. Prior to the World War a large number of business executives gave but little attention to the underlying principles of business. To a more limited extent this same situation prevailed during the prosperous period from 1920 to 1929. Perhaps the ever-pressing problems of the moment did not allow time for retrospection or for policy planning; perhaps business managers were lulled into satisfaction by the cumulative results of a period of prosperity, which, instead of their own directive efforts, had acted as the basic directive force for their particular business. Whatever may have been the cause, strikes, unemployment, the cancers of industrial peace and prosperity, until recently were given nearly

all the attention, while modest ailments and preventive medicine were overlooked.

The attention which our radio broadcasts, newspapers, and periodicals now give our industrial life has brought to all of us a knowledge of the importance of industrial policies and management in our modern economic structure. Not long after the beginning of the twentieth century this same knowledge was brought to many of our leading industrial executives. The number of these men who have come to realize that successful administration and management form the basis of all profitable business operations is increasing constantly.

With this awakening consciousness has come the dawn of a new industrial era, in which the administrative polices and managerial methods, rather than the nature of machinery, are the basis of the estimate of a plant's value to the community. A new concept of the industrial community is coming into being. Although we are in the midst of a period of transition wherein various factors in our industrial life seem to be irredeemably aligned against one another, nevertheless, executives are becoming keenly conscious of administrative policies and management techniques, periodicals are devoting increasing space to management problems, and the general public is beginning to realize that through the field of scientific management lies the path to a better understanding of industrial problems and thus to a better community life. The ultimate test of our present industrial system is its ability to adjust to the changing conditions of modern life. Management will largely determine whether or not our industrial system will meet this test.

Progressive establishments have been dealing for years with administration and management as separate business factors. They have realized the difference between drift and control in the operation of a business, and some of the outstanding business successes of the past two decades are tributes to the intelligent study of the hidden governing force of business. Competition in methods of distribution, and carefully analyzed selling methods have made many concerns stop and look beyond the methods of the moment which they have been using. Action based on careful analysis has been substituted for the older methods of operation, and has automatically brought with it better management.

The extent of management, within several businesses, is found to vary greatly. In past years, it has been difficult for the observer, however closely he may have looked, to see that scientific management has been a very great factor in some plants. The physical structure has seemed to run itself. Even if a few units within an industry have focused their attention on management matters, competition within that industry has frequently not been such as to compel other units to grant much

attention to management problems in order to survive, or even to make steady progress. Whole industries have pursued a policy of drift to the extent that they have been most unstable. Individual plants within an industry, interested in looking for profits, without providing for them, have become a source of financial worry, not only to their owners, but to those financial institutions which have been granting them credits.

The financial institution and industrial management. One of the pillars of industrial economic organization today may be said to be the financial structure which allows businesses to operate on borrowed capital while turning their purchases of raw material and payrolls into the cash of the consuming public. For many years, the financial institutions engaged in granting credits to manufacturing establishments were accustomed to look primarily at the physical side of the plant. The balance sheet of the factory, as expressed in terms of machinery, plant and structures, raw material, finished product, plus accounts owed or receivable, was the basis of extension of credit, subject, of course, to influences such as good will or the individual reputation of the managing executives. This last factor was the closest approach which these financial institutions had made to an investigation of the type of management within a plant. Good management was presupposed, and yet poor management could waste the assets of the factory to such an extent that the figures on the balance sheet might become changed immeasurably before the financial institution could clear itself.

Within recent years, financial institutions have come to appreciate industrial administration and management as vital business factors. Though they still require the physical balance sheet to come up to certain marks of safety before advancing moneys for operation, those banks which have been giving factory business the most mature consideration have been going far beyond the physical balance sheet in estimating the worth of the plant. Many banks have specialists on their staffs, whose duty it is to survey the administrative policies and management of a business as a supplement to balance-sheet information. Certain consulting companies make a specialty of evaluating the management or executive personnel of industrial plants for bankers. Associations of bank credit men are distributing to their members facts concerning the organization of specific industries and methods of management within those industries. Thus the credit man of the bank is enabled to determine some of the more intangible, hidden, but fundamental points of strength or weakness in the financial condition of the industrial enterprise.

Definitions. We have used the terms, administration and management, as vital factors in business, but we have not defined them. Unfortunately the two terms have not as yet received universal acceptance

in their specialized use. Some authors have used them interchangeably. Management is sometimes used as the broader term to include all the elements in the control of business activities, the correlation of the details of operation of an enterprise, so that they will work as a harmonious whole toward the desired goal. On the other hand, if *administration* is substituted for *management* in the foregoing sentence, it will conform to the usage of other writers. This is a regrettable situation.

In one sense management refers to the executive personnel of an enterprise, and is frequently used with special reference to those major executives largely responsible for policy formation and the determination of the major objectives. Such phrases as "top management" and "lower levels of management," when referring to the individuals who discharge the respective administrative or executive functions, are quite generally used regardless of the special interpretation given to the words, administration or management, when used in their more restricted sense. We shall continue this practice when the setting clearly shows that the reference is to executive personnel. Before defining management in its more technical sense it will simplify our problem if we have in mind the restricted meaning of administration.

Administration is that function of an enterprise which concerns itself with the over-all determination of policies and major objectives. Administration sets forth the general course to be followed in pursuing the predetermined goals and in striving to attain the organization's objectives. Administration sets forth the general purpose of the enterprise, establishes its major policies, formulates the general plan of procedure, inaugurates the broad program, and approves the specific major projects that fall within the general program. It should not be inferred that two sets of personnel are required to discharge the administrative and the managerial functions. There is usually a distinct overlapping of individuals in these respective spheres. The president may devote a great part of his time in a large institution to the broader administrative responsibilities; on the other hand, he is most certainly required to participate at least to a limited extent in executing these policies. It is highly probable that the combining of these two functions in the same person has contributed to the confusion in the use of the terms. The farther down the organization one goes, the greater is the shifting from responsibility of policy determining to execution.

Management is that function of an enterprise which concerns itself with the direction and control of the various activities so that the parts will be synchronized, thus working together to attain the objectives established by the administrative authorities. Management is essentially an executive function. It deals particularly with the active direction of the human effort. Administration determines the broad objec-

tives and establishes the major program. Management takes the broad plans laid down by administration and follows through the details to the ultimate solution. Administration is largely determinative, whereas management is essentially executive. The major responsibilities of the executives below the "top management" are managerial. It is true that many of the minor executives in a limited sphere determine policies within the groundwork established for the organization as a whole. When this happens these executives are performing administrative functions. The major function of the minor executive is not to formulate policies but rather to interpret them and to direct the activities of his particular unit in conformity with the organization's objectives.[1]

The goals of an enterprise. The executives of a business organization nearly always have very definite goals in mind when the enterprise is first created. The nature of the enterprise may change and the structural organization undergo many adjustments, but at least one of the original goals will remain, namely, to render invested capital and executive effort productive. The popular way to express this idea is that business is engaged in for the purpose of securing a profit. If the term "profit" is used in its popular sense, there is probably no serious objection to this statement.[2] Owners of capital have a right to expect a reasonable return on their capital when they place it in the hands of others for use, as they do in our corporate structures, or when they personally supervise it in the case of a single proprietorship. The enterprise that does not earn a fair return on its capital faces ultimate disaster. (It is not our function here to go into a detailed discussion of what is a fair return. The Supreme Court has placed it in the neighborhood of six per cent in the case of certain utilities.) When an enterprise earns less than what investors deem a fair return it cannot secure needed capital for expansion. Other industries in a more favorable situation will be able to make improvements and expand, thus putting the less favored one at a still greater disadvantage. In the long run the business that does not earn sufficient return on its invested capital to command additional funds when needed will be forced to close its doors, thus depriving its employees of the source of employment.

[1] See E. H. Anderson and G. T. Schwenning, *The Science of Production Organization,* John Wiley & Sons, Inc , New York, 1938, pp. 9-28, for a detailed discussion of the various usages of administration and management by different authors.

[2] The economist thinks of profit as the residual income after having paid rent for land, interest on capital used, both owned and borrowed, and wages to labor and the executives. Profits—if any—are available to the owners of the enterprise, the common stockholders in the case of a corporation, the partners in a partnership, or to the individual in the case of a single proprietor. In an accounting sense profits represent the excess of income over all expenses. Dividends on stock are not considered an expense.

The science of business has reached the stage in many instances that its practitioners are professional men. One of the distinguishing characteristics of professional men is a highly developed code of ethics that includes social objectives. A large number of trade associations and other groups of business men have adopted codes of business ethics. It is fully recognized that these codes are not always adhered to, but the same situation prevails in other professional codes, in social codes, or even in religious codes. The business man who makes a financial success of his enterprise, while operating within the generally accepted codes of business ethics or even on a higher level if possible, makes a real contribution to the community welfare. Long-run success in business brings success not only to the owners of the business in the sense of proprietorship risk-bearing, but to all who supply funds, materials, major and minor executives, workers, auxiliary enterprises, and the operating community. In a very realistic sense a successful business becomes a co-operative enterprise operated within the limitations of our capitalistic system of private responsibility and initiative. Profit motives not only are entirely compatible with social objectives but have thus far proved the strongest incentives to attaining these objectives.

One manufacturer will say that his goal is first and always profits; while another will say that, though it is true that he desires profits, yet he will not consider profits until his community of co-workers has a living wage. Another manufacturer may have a saving wage, rather than a living wage, as his prerequisite. In recent years many executives have reversed this point of view by holding that one of the aims of all businesses should be to pay high wages. They feel that unless high wages are paid, the purchasing power of consumers will be such that the product of industry cannot be absorbed, and hence profits will be low or vanish. The goals of enterprises also differ when profits are made in one case through large margins on small production, and in another case through small margins on large production. But in any case, the business that does not make a profit cannot long survive.

The general field of business administration and management is made up of three broad subdivisions: (1) the establishment of major policies, (2) the planning for, and setting up of, an organization to carry out these policies, (3) the operation of the enterprise through this organization. As business conditions change, fundamental changes are needed in each of these fields. If a plant does not make changes from time to time, as needed, it sometimes becomes necessary to engage in an extensive reorganization plan, which, because of its spectacular aspects, may come to be looked upon wrongly as the main field of the science of management. The best-advertised managerial effort has been reorganization, because it is spectacular.

Managerial and administrative responsibilities and duties call for the utilization of different types of genius, which are but seldom found in the same man. To establish policies and to plan for an effective organization require mainly creative ability, though this must be coupled with some ability to visualize methods of executing the plans that are devised. To operate a plant along the lines which have been laid down requires mainly executive ability. The manager who has this gift, together with the ability to create new policies, is the effective manager of the first grade.

Our aim will be to study the administration and management that have been most effective, to understand fully the hidden power behind the physical plant, and to see how it may be utilized best. In order to fulfill our aim, three steps will be necessary: (1) to determine the policies and principles of effective administration and management; (2) to see how they have been applied successfully; and (3) most important of all, to develop a scientific state of mind toward business problems. In order that we may appreciate more fully what business administration and management are and the position that they hold in our economic life, it will be desirable first to review briefly some historical aspects of American industry and the growth of "scientific management" as business factors.

CHAPTER II

THE HISTORICAL BACKGROUND OF INDUSTRIAL ADMINISTRATION AND MANAGEMENT

The value of industrial history to managers. One of the most frequent causes of poor management and accompanying business ineffectiveness is the tendency to overemphasize conditions that may exist at any given time. Even a brief study of industrial history helps to prevent glorification of the present and aids the executive to visualize more clearly the future policies of his enterprise.

The significance of the fact must not be lost, that the relationships of capitalist, manager, executive, and worker, as we know them in Europe or in America, are at most but slightly over a century old. Yet within this century the structure of our new industrial society has been changing constantly. Invention and the development of transportation, communication, and education have constantly increased human wants for manufactured products, and have increased the ability of the industrial world to satisfy these wants. Change has come to be the fundamental characteristic of manufacturing methods, both of technique and of management. What happened yesterday is of value in policy development, only in so far as it may aid in determining what may happen tomorrow.

Milestones in industrial history. The factory system is frequently referred to as the fourth of the milestones of industrial history, the first three of which are *domestic production, handicraft production,* and *cottage production.* The factory period itself, however, is composed of divisions as nearly distinct as the several periods themselves. *Domestic production* was production in the household for the members thereof, from raw materials furnished largely by the household itself. In its present form, found at any time only for a temporary period and only on the very frontiers of civilization, domestic production implies essentially an absence of exchange and the ability of each household to satisfy the wants of its members by its own labor.

Handicraft production was carried on either within or outside the house and is characterized by what is called "custom production." The handicraft worker usually worked for the consumer of his product, the region of the sale tended to be local, and the product of one craftsman might be bartered for the product of another, or an actual sale might take place. The rise and growing importance of the medieval towns

upon manor sites, accompanying the development of means of communication, aided materially in developing this new era of manufacture. The development of handicraft production was accompanied by the growth of guilds, or associations of workers in the same trade, banded together to promote their mutual interests. The growth of a particular guild in a town often caused that town to become the center of a particular type of manufacturing, and the guild in time came to control the town government as well as its trade. There was no large class of wage workers under the guild system, but each worker, having passed through his years of apprenticeship, could become a master of the craft. There was no employer or employee class. Although the guild system was the chief economic feature of the handicraft period, in many towns there was sufficient demand for the work of a craftsman in a particular trade, but not enough demand to attract a body of men who could form a guild in that trade. Thus, weavers and smiths who were not members of guilds would be found frequently. They, however, held an economic position similar to that of the guild worker, dealing directly with their customers.

The control of guilds over production did not survive up to the opening of the factory era, though, in a larger sense, handicraft production did. The gradual development of capital, the discoveries and explorations of the fifteenth and sixteenth centuries, and the consequent growth of trade together caused the power of the guilds to decay, partly because of their restrictive regulations, such as the strict limitations which they placed on the number of apprentices. During this period of the guilds the entrepreneur began to make his appearance in industry. The master worker or merchant who had accumulated some capital bought raw material and distributed it to workers, later collecting and distributing the finished product, either directly to consumers, or to merchants. In the sixteenth, seventeenth, and the early part of the eighteenth century, this method prevailed in the manufacture of staple commodities and became the forerunner of the factory system. This plan caused the era to be called the "cottage period' of industry, since so much of the work was done in cottages just outside of towns. The workers still owned the tools of production, but the contact with consumers of their product was made for them by merchants This practice is by no means unknown to our present era. Many sections of Japan today carry on this type of manufacturing extensively. A similar situation prevails in our Southern states in connection with home work in the manufacture of candlewick bedspreads, chairs, etc.

The little manufacturing that was allowed to go on in the American Colonies prior to the Revolution may be thought of as being of the cottage type. Some of it was pure handicraft production, though practically without any associations resembling guilds.

There arose some few instances where workers were grouped together. In the sixteenth century there were a few "factories" where handicraft workers could be brought together to perform their duties under one roof. It is estimated that in Germany just prior to 1800 there were at least twenty such establishments, each employing between one hundred and five hundred persons. However, not only were these factories the exception, but they did not represent any real change in methods of production or in the economic structure of industrial society. These factories were essentially an extension or outgrowth of the domestic system of production. They existed side by side with the handicraft system. Specialization of labor took place to a limited extent, yet they should not be thought of in the sense of the modern factory. Had it not been for the Industrial Revolution, it is conceivable that these factories might well have replaced the prevailing handicraft system, thus producing social dislocations similar to those that followed the Industrial Revolution in England.[1]

Trade expanded during the Middle Ages. The merchant group expanded into a capitalistic class. This was not a sudden, but a gradual movement. Wealth began to be concentrated in the hands of this capitalistic group, but as yet there had been developed no instrumentality through which this capital could be utilized so as materially to increase production.

The birth of the factory system. The birth of the factory system provided the outlet for this capital. The chief factors bringing about this new scheme of industrial production were four inventions made in England during the closing years of the eighteenth century, providing machines for the textile industry. James Hargreaves' "spinning jenny," patented in 1770, but in use several years before, was the first machine to spin yarn. This was improved upon in 1771 by Richard Arkwright in the invention of what he called his "water frame." In 1779 Samuel Crompton constructed his "mule," so called because its construction embodied features of both previous inventions. This device increased the potential production of yarn beyond the ability of the weavers to make it into finished fabric. This was directly contrary to conditions prior to the invention of Hargreaves' jenny, when the use of a "fly-shuttle" (practically a hand device) had given weavers a capacity for work that could not be met by the spinners. By this time, however, the invention of textile machinery had gained a fair start and the need was met by the fourth great invention, that of Edmund Cartwright's "power loom" in 1785. All these inventions served, within comparatively few years, to revolutionize the textile industry—that industry which, possibly more

[1] See Dexter S. Kimball, *Principles of Industrial Organization*, 4th Ed., McGraw-Hill Book Co., Inc., New York, 1933, p. 8.

than any other, is closely interwoven with human wants and human progress—and place it on a machine basis. Although it was not until the invention of the steam engine by James Watt, and its adaptation to factory work in the closing years of the century, that industry broke away from the hampering limitations of the use of water power; nevertheless, the real Industrial Revolution, the change toward the factory system, had begun.

Similar inventions or changes in method took place simultaneously or shortly thereafter in many lines of work, particularly in metal-cutting. The slide-rest for accurately guiding cutting tools, the turret, and the combination of these two elements into the automatic lathe, by Christopher M. Spencer, of Connecticut, were the great epoch-making improvements in machine-tool construction, and these were all made at about this time. It would be difficult to overemphasize the importance of these metal working tools. The lathe, shaper, planer, and milling machine are known today as machine tools. They can be and are frequently used in so-called mass production, but they are essentially general-purpose machines in contrast with special-purpose production machines. The machine tools are used in making the production type of machines. Motors, pumps, generators, and special-purpose high-production machines are produced with the precision type of machine tool. To illustrate, Watt was thoroughly familiar with the principles of his steam engine long before he was able to build a production engine. He was forced to wait more than a decade before a lathe was devised to turn the cylinder with sufficiently accurate dimensions from the bottom to the top.

Effects of the Industrial Revolution. The effect of the Industrial Revolution on such industries as were established in the United States was felt almost as quickly as in England, because once machines were set up, hand labor could not compete if some means of fairly cheap transportation were at hand. The first cotton factory of any importance in the United States was established in 1790, but the Industrial Revolution is still going on. Its beginning, which rocked the very basis of industrial society, lay in those early inventions of the late eighteenth century. Yet as late as 1850, in the United States, some trades, such as shoemaking, had barely been touched by its influence, and the old conditions of master, journeyman, and apprentice still were characteristic of the industry. Such differences as existed in the effect in the United States and England lay in the fact that England was primarily an industrial country, whereas there was but little manufacturing in the United States. Therefore, the immediate effect on the social and economic life of the people in America was less marked, though largely governed by the same influences.

It was not the overcrowding of towns which was the great economic result of the development of the factory system. Factories had already

been erected prior to the "four great inventions," and, in any case, there probably would have been an increasing tendency to centralize work in larger units. The real change is found in the new status of workers in manufacturing. It was the transfer of skill involved in the introduction of the factory system that brought about this changed status. Many of the conditions of modern industry are directly related to this transfer of skill. Included in these are the fact that workers of today are divorced from direct interest in the final product and the tools of production; and the fact that they have but little control over conditions of work, except as conditions are limited by workers after the employer has taken the initiative.

Prior to the Industrial Revolution, it was the worker who had the skill; now the skill is largely to be found in the machines. Prior to this time all machines were used to aid the worker in performing his task; now the worker aids the machine. Today, in shoe factories, the shoe-hand who can make a complete shoe is the exception. All can make parts of shoes well, owing to the lodging of the traditional craft skill in such machines as the welt-machine and the pulling-over machine. The skill of the trade and of the inventor has been transferred to the machines, and an operator with but little skill or training can be taught quickly to handle the machine and turn out the product.

Another illustration of the transfer of skill from the worker to the machine is the case of the furniture manufacturer. Under the old régime and even today in the small-scale custom production shop the workman was a cabinet maker, one of the aristocrats among skilled workmen. When volume justifies the expense involved, practically all such work as cutting to lengths and shaping is reduced to machine operations, with only the assembling in fixtures done by hand. An alert farmer boy or girl could easily learn to make this assembly in a three-day period. The cabinet maker served an apprenticeship of four years. The product of the present assembly is more uniform than that of the skilled mechanic under the hand-assembly method.

Since transference of skill involves, at least temporarily, loss of earning power for the particular workmen involved, it is not hard to account for workmen's frequently opposing the introduction of new machinery. The skilled worker found himself immediately and automatically degraded, in many cases, to the level of unskilled girls and boys, who could operate the new machines. The degrading effect of transferring skill from the worker to the machine was not permanent in regard to the working class as a whole. Large groups of workers were soon needed to produce the machines with which the others worked, and this, together with the general expansion of industry, afforded increasing employment for skilled men. Frequently, however, the individual suffered, as in the

case of the skilled weaver, whose place was taken by the automatic loom, the skilled work was largely done by the metal worker, in an entirely different trade. The result was the economic degrading of the displaced skilled worker and an increase in the number of skilled workers required for the manufacturing and servicing of the tools and equipment making a net gain to society as a whole, but a distinct loss to the group displaced. These new machines were operated by the group that formerly comprised the unskilled workers. They now became semi-skilled operators, a change which raised their economic status. The decreased cost of the finished product widened the market, thus increasing the total number of units required and making possible a general rise in the standard of living.

Opposition to new machinery was strong even in the early days of the Industrial Revolution. A mob of spinners wrecked the first machine built by Hargreaves. An early American illustration of the opposition of vested interests of workmen to the introduction of new equipment and methods is significant. When the West was first being opened, materials and supplies were transported across the mountains from Virginia and North Carolina into Kentucky by pack trains of horses and mules. This was a slow and expensive method. Soon the trails were widened and wagon trains began to move westward. The pack train drivers opposed this method and rolled stones down the mountain sides to destroy the wagon trains and the new roads. The idea has persisted even to the present. Certain N.R.A. codes specifically forbade the introduction of improved machinery. Congress was influenced by pressure from organized labor to insert a provision in the Emergency Transportation Act of 1933 to the effect that action taken under this Act should not reduce the number of employees below the number employed during May, 1933, after deducting the number removed by death, retirements, or resignations. Opposition to the introduction of new devices may be directed toward machinery which itself increases output or absorbs workers' skill. However, it often has been directed toward devices or management methods which study processes or measure output in order that management may know better how quickly work should be done.

The effects of the transference of skill were far-reaching and complex. One immediate effect, and one of the most significant, was to separate the worker from the ownership of the tools of industry. No longer was it possible for the apprentice, becoming a craftsman, to be presented by his proud mentor with the implements of his trade. Capital was now required both to build these new implements and to provide power to operate them. The rise of the capitalist class, already begun, was therefore necessarily accelerated. The immediate results, particularly in England, of the rapid rise of this newer class in society and the accom-

panying degradation of the worker are well known. Had it not been the day of the economic doctrine of *laissez-faire* and had not Britain been engaged in a long series of foreign wars, the industrial history of that period might have been different, but it now stands as the historic example of frightful working conditions—child labor to the point of death in childhood, and general inhuman treatment of the worker. It was but the natural result of too-rapid transition from one economic era to another.

The factory system in the United States. The immediate results of the Industrial Revolution in the United States were less deplorable socially because the country was new, manufacturing was relatively unimportant, and full opportunities existed in agriculture for any industrial worker who might fall under such conditions as those existing in England. When the manufactures of the United States began to grow in the second decade of the nineteenth century, the factory system was established, and its social effects were not so severe as in Europe, where different manufacturing conditions were overturned. The factory system in the United States today bears no resemblance to that of 1850 and very little to that of 1880. There have been fairly distinct periods, during which various aspects seem to have been more important than others, but no fine limiting date lines can be set for each period. The three most important divisions have been: first, that in which the structure was started and the foundations were laid; second, the period of great industrial expansion; and third, the period of attention to operating methods.

The beginnings of American industry. The first period is characterized by small factories, patterned basically along European lines, with relatively narrow markets and organizations dominated by the owner, or capitalist. The growth of a middleman organization and a financial organization to market the rapidly increasing product of the factories also is characteristic of this period. American manufacture had, as a basis for its early growth, the transplanting of European industry, almost bodily, to the shores of this country. European workmen, European machinery, frequently European superintendence and even European raw materials formed the entire groundwork for the establishment of our early manufacturing.

Though markets were broadened in the first half of the nineteenth century by transportation advances, such as the beginning of railroad building, yet they were narrow, compared to the markets that we know today. Though the limitations of state boundaries meant nothing when compared to those of national boundaries in Europe, yet it was unusual for one manufacturing community to attempt to sell in another, except as it possessed some product not made in the other locality. Means of communication usually did not allow any attempt at national distribu-

tion. Nevertheless, markets were constantly broadening, and groups in the community began to arise to take charge of the marketing function. The development of the merchant class, which, we have seen, was in existence long before the formation of the manufacturing-capitalist class, quickly progressed. The structure comprising jobber, wholesaler, and retailer, with which we are familiar, grew up. Trade customs came to be established in certain industries, as in branches of the textile industry, whereby all goods were produced primarily for a middleman, who took over all phases of the marketing.

A financial group arose whose business it became to provide the means of carrying on the rapidly increasing transactions between these newly established groups of industrial society. The larger the competitive area over which a product was distributed, the more necessary became the services of the financier, thus his growth to a dominating position in industry followed the increasing development of markets.

The characteristically small plant of this period was dominated by the owner, who was usually to be found in the factory during working hours, except when engaged in distributing his product. Workers found opportunity for personal contact with the owner of the business, and frequently for personal expression of their craftsmanship in the finished product, even to the extent of changes in design. The owner, whether he was on good or bad terms with his men, was well known to all of them, sometimes by the half-affectionate title of "the boss," and usually to many of the older employees by his first name. The worker was accustomed to remain at his place of employment for years, the personal contacts which he formed with the owner doubtless proving to be one of the strongest inducements in this direction.

Despite this opportunity of personal contact, labor troubles were numerous, and could hardly be called less violent than those now experienced. They were, however, sporadic and unorganized. Strikes occurred, many being caused by the attempt to bring into manufacturing the long hours of agriculture. It was many years before the ten-hour day became common, and this was secured only after constant struggle. The governing philosophy of modern management had not even caught a foothold in the industry of the time. There were many attempts to form labor organizations, some of which were successful for a time, but there were no national union organizations, such as those with which we are familiar. Those that were successful were local associations of local workmen in specific trades.

The period of great industrial expansion. The second period, that of the great industrial expansion, saw the United States rise from the position of a novice among nations in manufacturing industry to the position of the greatest manufacturing nation in the world, both in di-

versity and in amount of product. Abundant natural resources, a rapidly increasing home market among people whose wants were large, and manufacturing ability which seemed to combine and intensify the variety of skills of the many population elements caused this growth in manufacturing industry. Not only was this home market larger because of the unsatisfied wants of a growing population, but the size of this market was important from a political and geographical standpoint. Business flowed freely, unhampered by tariffs and other barriers, from Maine to California and from Puget Sound to Florida. Few places in the world existed in which the natural resources combined so favorably with the temperament of an ambitious people and unfettered political boundaries.

The United States, a new country, willing to absorb and further develop new ideas, readily secured the benefits to be found in the logical development of the factory system. The division of labor resulting from the first machine inventions was further increased as manufacturing method under the factory system developed. With each invention of a machine, division of labor was likely to increase. Increased division of labor made possible further construction of machines to perform the simplified operations creating a reciprocal relationship. Thus the spiral of simplification of operations and machine development continued. They became both cause and effect when looked at from different points of view in the cycle of development of production equipment. Transfer of skill to machines made possible the reduction of manufacturing costs, which brought wide markets that made possible increased production. Increased volume of production encouraged simplification of operations and justified expenditures for further mechanization. As production became greater, economies in the purchase of materials, indeed, the control of sources of supply of materials, became possible. Integration of the various steps in production of raw materials and manufacture permitted more refined products. As size of industries increased, more and more capital was attracted, which made possible further development of integration and mass production, and by reducing costs, widened the markets. Capital began to be used as a means of founding and financing huge enterprises which could not have existed without its aid. In the adaptation of all these conditions, the lead was taken by the United States, which, instead of being the pupil, came to be the teacher in most phases of manufacturing promotion and manufacturing method.

With the foundations of a huge domestic market already laid in the first period, the development of means of transportation and communication, beginning early in the last half of the nineteenth century and reaching to the present, literally made all the world a neighborhood in which

products purchased are made through a radius of thousands of miles. While markets have been broadened, the ability to secure raw materials has likewise expanded; even workers move from one locality to another as conditions dictate, and thus competitive conditions have been made over. The service rendered industry by improved communications cannot be measured; without the growth of the railroad map and railway shipping accommodations and service, taking place simultaneously with the development of the telegraph and telephone which make possible the dissemination of news and market information, there could have been no such industrial growth as has occurred.

The invention of the steam engine, by Watt, helped to revolutionize industry, but the development of the dynamo and electric motor created real industrial power. The first machine inventions brought in the factory system, but constant inventions and improvement increased the capacity and technical efficiency of industrial plants to undreamed-of proportions in those same industries. Invention during this second period of American manufacture founded great new industries, filling new wants and creating whole new markets. A rising standard of living broadened the market which for these and other products might previously have seemed glutted. We look upon the great iron and steel industry as the barometer of our trade conditions, and yet, one hundred years ago, the iron on railway tracks consisted of a thin strip laid on top of wooden or stone rails; and steel frame buildings are a development of recent years. The use of electricity for power, communication, and light has founded, within the last three-quarters of the century, one of our great basic industries. The successful use of the gasoline engine for transportation purposes has given us within the last forty years the automobile industry, one of the truly great industries of the country, whether it is considered from the standpoint of value of product, number of people employed, or manufacturing method. The beginnings of all these industries, the improvements in manufacturing technique, the improvement in product which followed and broadened the market for each, are all characteristics of the second period in American manufacturing.

As manufacturing grew, and new industries came into being, there was developed the "American type" of manufacturing, the production of standardized, interchangeable parts. Eli Whitney is known to every sixth-grade American schoolboy as the great inventor of the cotton gin, but few of them know that his greatest contribution to modern industrial practice was the introduction of the manufacture of standardized interchangeable parts. American manufacturing developed so rapidly, under conditions entirely different from those of Europe, that it soon found itself practically free from the bonds of European influence.

It is the difference in the size of organizations, rather than their form,

which is responsible for the changes in owner-worker relationships which occurred. In many corporations, however, the owners became so distinct from the management as to cause the growth of new operating problems. We have heard much in recent years of the absentee owner who is interested but little in the details of administration and management so long as he receives a fair return on his investment in the stock of the corporation. This phase of industry will be discussed in greater detail later under forms of organization and ownership.

The growth of labor unions, organized along present lines of the American Federation of Labor, is another of the developments of this period. The labor unions exist as the crystallization of the labor movements of earlier American industry and of forces in existence since the guilds. They also exist in direct response to conditions caused by the growing impersonality in the operation and incorporation of manufacturing enterprises, as well as in response to the necessities of self-protection brought about by the flood of immigrants in the last part of the nineteenth and the beginning of the twentieth century. The recent growth of the Congress of Industrial Organization is a further attempt of the labor movement to adjust to corporate large-scale mass production.

The opening of the third period. Attention to operating methods. Gradually, manufacturers in many lines began to find that their normal productive capacity was greater than their market. Although market demands had increased with a growing population, higher standards of living, and the development of new products, manufacturing capacity had grown even more rapidly. Many companies were also beginning to give attention to economies in production and accurate cost-finding methods that gave them an advantage in fixing selling prices. Rivalry within industries caused plants to lie idle for lack of orders, and to begin to combine with competitors in an effort to reduce distributing costs and overhead charges, as well as to provide production economies. National advertising came to be a major factor in distribution methods in order that markets might be enlarged and trade secured from competitors' customers. Great inroads began to be made on the jobber-wholesaler-retailer method of distribution, which previously had characterized American industry. These changes marked the opening of the third period.

The scientific industrial age began to arise out of the changed conditions. Attention to methods of operation is the outstanding feature of this era. Savings through better organization, savings through stricter accounting, savings through more effective distribution, and savings through more effective factory operation, all are considered, thrashed over in executives' meetings, and adopted as a part of plant policy.

The tendency toward the creation of larger enterprises continued up

to the beginning of the depression of 1929.[2] At least, there was a definite tendency to create "interests," which controlled many enterprises from a central location. The giant corporation, owned by hundreds or thousands of investors, has become common. This implies control of many plants through operating or managing representatives of the owners, financial representatives, sales representatives, and production representatives. In this lies an additional cause of attention to operating methods. In such types of organization, attention to managerial methods is essential and fundamental.

Diminishing influence of the stockholder upon administrative policies and management. The corporation is owned by its stockholders, who meet in person or by proxy once a year to pass on certain policies referred to them by the board of directors or originated by the stockholders at a regular meeting; also to elect a board of directors to represent them in the active conduct of the enterprise. Theoretically the annual meeting of the stockholders is very important in policy-determination and in the selection of the representatives to conduct the business. Practically, it does not work out so simply. During the past twenty years the ownership of the voting stock of our large corporations has undergone a marked change. Stocks have become widely distributed. The American Telephone and Telegraph Company is reported to have somewhat more than nine hundred thousand separate stockholders. The General Motors Corporation, according to its annual report for 1938, had 389,509 individual stockholders. The Vick Chemical Company in its report for the year ending June 30, 1938, stated that it had some thirty thousand stockholders; that the entire holdings of its board of directors amounted to less than fifteen per cent; that "the largest single group of stockholders, the Richardson family—original holders of the majority stock of the Vick Chemical Company—held less than seven per cent of the stock outstanding;" that "in four years the high water mark in attendance at any Vick Chemical annual meeting was three stockholders outside of those connected with the company." The report further states, referring to the absentee stockholders, "They vote by proxy, giving the right to cast their votes to nominees, whose names are printed in the proxy form—printed there by the Management, which necessarily, in the circumstances, *must assume the responsibility which formerly was carried by stockholders and directors.* 'Absentee' voters therefore have forced the Management of many companies in the United

[2] For the past few years (1940) there has been much discussion in managerial and economic circles relative to the optimum size of an enterprise for maximum efficiency. This discussion has also entered the field of political economy. Certain punitive tax laws have been passed in individual states directed at chain stores. Just where this movement will end no one can safely predict.

States to assume the responsibility of *self-perpetuation*—that is, the Management, for all practical purposes, is elected not annually but for life."[3] These cases are not isolated ones by any means. They point to difficulties in direct action by the stockholders that are almost insurmountable. For instance, there are practically no buildings in the United States large enough to hold even *five per cent* of the stockholders of the General Motors Corporation should they decide to attend the annual meeting in person to participate actively in the determination of policies and the selection of the directors. Most stockholders are content to perpetuate the existing management, particularly if reasonable dividends are being paid. This trend in administrative and management structure is an outgrowth of the third period in the development of American industry. It has brought into existence the professional manager with pressure from the outside for dividends. The real owners of our industries are relatively silent in their management and administration. This situation raises new problems and makes it imperative that there be a profession of management that is truly scientific, with deep-rooted traditions of social justice to all.

Effects of the World War (1914-1918) on American industry. Under the influence of patriotism and supported by government contracts of "cost plus," both managerial attitudes and labor co-operation underwent a change that in fact was revolutionary when compared to performance prior to this period. Habits formed in war times carried over into peace-time operations. It would be unusual indeed to find an industry that made war supplies that did not have its peace-time operating methods changed through being forced out of the well-worn ruts of years of operation. There were other similar effects of the War, as we shall see later when considering the scientific management movement separately.

The War ended with distinct unrest among a large percentage of the wage-earning group. A considerable part of the immediate unrest could be traced rather directly to many men who had been taken from the workbenches for the first time, shown other fields and, in general, made desirous of change, whatever that change might be. But something fundamental to industry came from the War. There came into the minds of all, employer and employee, an increasing sense of the importance of the individual worker to industry. Whereas, prior to the War, the emphasis in managerial matters was given largely to the physical aspects of management, such as plant, equipment, and materials, the emphasis since the War has been equally on the human element.

[3] See Vick Chemical Company, *Annual Report for the Year Ending June 30, 1938*, p. 22, for an extended discussion of this problem and one method of discharging this responsibility.

A fundamental change in attitude on the part of the directors of industry has developed.

At the beginning of the factory period, the employer and the manager were one and the same. Later, as capital came to be accumulated in larger amounts, the capitalist frequently ceased to be active in the business which his efforts had made possible. With the growth of the great corporation this distinction between the capitalist, or owner, and the manager, or operating head, has become more and more intensified. As was previously stated, owners are scattered over large areas, but the operating heads must be near the business. This condition has been of real advantage in building up a technique of management, and in creating a group in the community whose paramount interest is the effective operation of industrial companies.

Yesterday the factory system was developing and machine production was growing; today the machine is more important than ever, and unbelievable strides are being made in having machines do today what workers did yesterday. Industry in the United States is contrasted with industry in Europe in no more vivid way than in use of power, and hence mechanization of production. With a use of more than ten horsepower per capita in the United States, power consumption is nearly twice per capita that of the greatest power-using country of Europe, England. The productivity per worker varies between these two great industrial countries in essentially the same ratio as the horsepower used. The higher standard of living of the American worker is not the result of any great superiority of the worker per se, but rather the superiority of the tools with which he works and the abundance of natural resources. Natural resources alone will not account for it, because other countries such as Russia have great natural resources, but are short on productive equipment and trained workers. A high standard of living requires a happy balance of natural resources, man power, capital, and managerial skills.

The industrial scene has changed, and the change is becoming more apparent year by year. There are some employers, some large corporations, even, that are living in the era of yesterday. Some may still exist because of particularly favorable conditions which give them monopoly power; but others live in that era without such protection, not realizing that they are in danger and that the industrial world has moved onward another step into the era of scientific operation. Many such enterprises are "taken over by their bankers" during times of depression.

This age of management in industry is new. Though industry is centuries old, the factory system has existed for little more than one century, and the conditions of modern industry that have given rise to

present-day management problems, for only a few decades. The very youth of the present economic conditions is the cause of many managerial problems that now exist The science of management is a new one, with even its shallower waters unsounded, a science wherein every factory, every organization, is a new world, and every worker in industry a potential explorer and a prospective discoverer.

CHAPTER III

THE MANAGEMENT MOVEMENT

Coincidently with the rise of interest in management matters among the general industrial community, there has been developing what may best be termed "the scientific management movement." This movement, which involves personalities, has been progressing together with industry and yet separately from it, actuating industry almost from without. By considering this management movement separately, it becomes possible to trace more definitely the various stages in the changes that have been occurring. A discussion of this movement will also aid in clarifying some issues, and possibly in eliminating doubts.

The closing decades of the nineteenth century and the first two decades of the twentieth century may aptly be called the period of the captains of industry. These men were founders and builders of great industrial empires. Practically all of them were men of vision and dominant personalities. They were pioneers in a new country and in new fields in a growing country. The philosophy of *laissez-faire* dominated their activities. This period produced John D. Rockefeller, Sr., the moving spirit in the oil industry; James J. Hill, the railroad builder; John Patterson, who provided the cash registers for the new industrial era; Henry Ford, and the Dodge brothers, Horace and John, founders of automobile industries bearing their respective names; Harvey Firestone and F. A. Seiberling, two dominant figures in the rubber industry; Marshall Field and John Wanamaker, who revolutionized certain aspects of retailing; Thomas Edison and the Wright brothers, great inventors who laid foundations on which others have built great industries; and many other strong individualists whose influence will be felt long after their names are no longer familiar to the school children in America.

These strong men defied custom and created when others thought the task was impossible. Their beginnings in general were humble, such as the bicycle shop of the Wrights and the small machine shop of the Dodges, yet most of them lived to see their work prosper to an extent little dreamed of even by them in their early efforts. In a very real sense they made the period and the environment made them, a reciprocal relationship, the one influencing the other. They grew with

their enterprises. They possessed an intimate detailed knowledge of each phase of their undertakings. They were leaders by right of natural and acquired abilities and in a few instances, great fortunes. These men as they grew carried enormous personal loads and responsibilities. They developed the facility for ease and speed of decisions. This capacity was enhanced by complete mastery of technical details and the assumption of responsibility early in life. With the passing of the founders and the dividing of their responsibilities among others, additional attention was focused upon organization and managerial methods.

Fundamental factors in the industrial situation, some of which have been pointed out above, would have caused the management movement, in some form, to have come about within a period of perhaps a quarter-century. Of that we can be reasonably certain. However, the exact form of the movement and its starting place were determined, as is not unusual, by the life work of one great man. This man, seeing around him the need for the development of management, even as many other men probably saw it, was not content merely to sit idly by and look on, but began the intensive study of corrective measures, which finally led to the development of the science of management, of which he is the recognized founder.

Frederick W. Taylor. In whatever branch the management expert may be working at the present time, or whatever methods he may use in his particular development of the science, the true expert, who has studied the history of the movement as well as the details of method, will always gladly say that his work is but the development of the foundations laid, between 1880 and 1890, by Frederick W. Taylor. Taylor was the man with the vision, the father of modern scientific industrial management, not only in the United States, but throughout the world. There never has lived a man whose individual work so largely influenced the operation of so many plants in so many and diversified industries as did the work of Frederick W. Taylor. His first work was small in itself and was finally largely voided by opposing factions. His influence, though not dormant, was both consciously and unconsciously disregarded for twenty years; and yet, in the development of management methods, it has been greater than that of any other single man.

Taylor was himself strongly influenced when still comparatively young by knowledge of the work of Henry R. Towne, then President of the Yale and Towne Manufacturing Company, who began the application of new management methods as early as 1870 in the plant of that company. It was probably the example of Towne that caused Taylor to direct his efforts to the organized study of management as a science and as a profession. But, although Towne may have been the pioneer,

Taylor was the great leader of the movement. At the time of Taylor's death, Towne himself referred to him as "one of the world's discoverers and creative leaders," and as "the creator of a new science."

Another personality that greatly influenced the early work and entire philosophy of Mr. Taylor was his chief, William Sellers, one of America's greatest engineers, possessing a keen understanding of his young assistant's enthusiasm and a profound respect for research. Taylor did not have to struggle to get permission to make his early experiments. Sellers encouraged him in his efforts and made available to him equipment suitable for the researches. The keen analytical ability of Carl Barth, one of Taylor's assistants at the Bethlehem Steel Company, aided him greatly in refining techniques and in the use of mathematical tables and processes. Others influenced Taylor's growth and work, but he remained the guiding genius and motivating force of the scientific management movement. Taylor occupies the same position in relation to the science of industrial management that Darwin does to the modern approach to the pure sciences. Taylor introduced Darwin's techniques to industry.

Early steps of Taylor. In 1882, after transferring from the offices to the shops of the Midvale Steel Company, in Philadelphia, Taylor was promoted to machine-shop foreman in the Midvale plant. During his previous experience as a workman, Taylor had been constantly impressed by the failure of many of his fellow-workers to produce more than a third of a good day's work. Wages had been on a piece-work basis, and the men were afraid to let the management know how much work they could really do, for fear that the rates would be cut. When Taylor became foreman, he was determined to work out some system of management by which the interests of the management and of the men might be made as nearly as possible the same.

The constant thought in the mind of Taylor in those days was that the difficulty at the root of the whole matter was lack of knowledge of what actually should constitute a day's work. How could the man be held accountable for his full duty when the management had no idea of the man's capacity? It was on this thought as a foundation that most of his writings, researches, and influence over other men were built. He found that management did not really manage. It would be necessary to change entirely its attitude toward its responsibilities in this direction before the workman could be expected to change his attitude with relation to his work. Taylor felt that the management was asking the worker to do its work as well as his own. His efforts to secure information at Midvale concerning ways in which management might really manage enabled him to develop what he termed the "duties of management," that guided him and many others along newer industrial

paths. These duties were changed in phraselogy by Taylor from time to time, but their substance was as follows: [1]

First: The development of a science for each element of a man's work, thereby replacing the old rule-of-thumb method.

Second: The selection of the best worker for each particular task and then training, teaching, and developing the workman in place of the former practice of allowing the worker to select his own task and train himself as best he could.

Third: The development of hearty co-operation between the management and the men in the carrying on of the activities in accordance with the principles of the developed science.

Fourth: The division of the work in almost equal shares between the management and the workers, each department taking over the work for which it is better fitted instead of the former condition in which most of the work and the greater part of the responsibility were thrown on the men.

Taylor remained at Midvale until 1890. While there he also carried on early experiments in the development of high-speed steel. His discovery of this product, in which he was associated with Maunsel White, ranks as an achievement equal to the founding of the modern management movement. The work which he did on high-speed steels was in fact an outgrowth of his attempts to find the right way to do jobs. When Taylor left Midvale it was largely due to factional differences within the organization, and this fact naturally led to the undoing of much that he had accomplished. Nevertheless, even today many of the practices in the machine shops of this plant can be traced directly back to the time when Taylor was first working with management methods there.

For several years Taylor did not have an opportunity to carry on, upon a large scale, the work that he had begun at Midvale. Though engaged in a number of undertakings in which he aimed to improve managerial methods—several of which, by the way, were largely concerned with improvements in cost accounting—there was no one great work carried on in one plant.

At the Bethlehem Steel Company, beginning in 1898, for three years, with the assistance of a large and competent force of assistants, he reorganized the management and methods of two of the larger machine shops and the foundry, and at the same time completed the development of his metal-cutting experiments. It was at Bethlehem that interesting studies in pig-iron handling and shoveling were made, which since have become classic in the field of management. One of the most important of the wage-payment systems was also developed during this time.

[1] F. W. Taylor, *Principles of Scientific Management*, Harper and Bros., New York, 1919, p. 36.

After Taylor had been at the Bethlehem Steel Company for about three years there was a change in the directorate and executive management of the company. The group which came in was unfamiliar with, and apparently antagonistic to, the methods pursued by Taylor and his staff. Taylor and his associates left. This withdrawal was followed by changes in method by the new management, and since it so closely followed the upheaval at Midvale it cast a shadow on Taylor's work which took some years to live down. This accounts for the slow development of his ideas during the immediately succeeding years. Among the more important plants in which Taylor or his direct associates worked in this period were the Tabor Manufacturing Company and the Link-Belt Company of Philadelphia and the United States Arsenal at Watertown, Massachusetts.

The Bethlehem Steel Company illustration of handling pig iron. Probably the best method of portraying the careful techniques used by Taylor in his work is to use his own words in describing the timing of the operation in loading pig iron.

> This was done by timing with a stop watch a first class man while he was working fast. The best way to do this, in fact almost the only way in which the timing can be done with certainty, is to divide the man's work into its elements and time each element separately. For example, in the case of a man loading pig-iron onto a car, the elements should be: (*a*) picking up the pig from the ground or pile (time in hundredths of a minute); (*b*) walking with it on a level (time per foot walked); (*c*) walking with it up an incline to car (time per foot walked); (*d*) throwing the pig down (time in hundredths of a minute), or laying it on a pile (time in hundredths of a minute), (*e*) walking back empty to get a load (time per foot walked).
>
> In case of important elements which were to enter into a number of rates, a large number of observations were taken when practicable on different first-class men, and at different times, and they were averaged.
>
> The most difficult elements to time and decide upon in this, as in most cases, are the percentage of the day required for rest, and the time to allow for accidental or unavoidable delays
>
> In the case of the yard labor at Bethlehem, each class of work was studied as above, each element being timed separately, and, in addition, a record was kept in many cases of the total amount of work done by the man in a day. The record of the gross work of the man (who is being timed) is, in most cases, not necessary after the observer is skilled in his work. As the Bethlehem time observer was new to this work, the gross time was useful in checking his detailed observations and so gradually educating him and giving him confidence in the new methods.
>
> The writer had so many other duties that his personal help was confined to teaching the proper methods and approving the details of the various

changes which were in all cases outlined in written reports before being carried out.

As soon as a careful study had been made of the time elements entering into one class of work, a single first class workman was picked out and started on ordinary piece work on this job. His tasks required him to do between *three and one-half* and *four times* as much work in a day as had been done in the past on an average.

Between twelve and thirteen tons of pig-iron per man had been carried from a pile on the ground, up an inclined plank, and loaded on to a gondola car by the average pig-iron handler while working by the day The men in doing this work had worked in gangs of from five to twenty men.

The man selected from one of these gangs to make the first start under the writers' system was called upon to load on piece work from forty-five to forty-eight tons (2,240 lbs. each) every day.

He regarded this task as an entirely fair one, and earned on an average from the start $1 85 per day, which was 60 per cent more than he had been paid by the day rate This man happened to be considerably lighter than the average good workman at this class of work. He weighed about 130 pounds. He proved, however, to be especially well suited to this job, and was kept at it steadily throughout the time that the writer was in Bethlehem, and some years later was still at the same work.

Being the first piece-work started in the works, it excited considerable opposition both on the part of the workmen and of several of the leading men in the town Their opposition being based mainly on the old fallacy that if piece work proved successful a great many men would be thrown out of work, and that thereby not only the workmen but the whole town would suffer.

One after another of the new men who were started singly on this job were either persuaded or intimidated into giving it up. In many cases they were given other work by those interested in preventing piece work, at wages higher than the ruling rates In the meantime, however, the first man who started on the work earned steadily $1 85 per day, and this object lesson gradually wore out the concerted opposition, which ceased rather suddenly after about two months. From this time on there was no difficulty in getting plenty of good men who were anxious to start on piece work, and the difficulty lay in making with sufficient rapidity the accurate time study of the elementary operations or "unit times" which forms the foundation of this kind of piece work.

Throughout the introduction of piece work when after a thorough time study, a new section of work was started, one man only was put on each new job, and not more than one man was allowed to work at it until he had demonstrated that the task set was a fair one by earning an average of $1.85 per day. After a few sections of the work had been started in this way, the complaint on the part of the better workmen was that they were not allowed to go on to piece work fast enough.

It required about two years to transfer practically all of the yard labor

from day to piece work. And the larger part of the transfer was made during the last six months of this time.

As stated above, the greater part of the time was taken up in studying "unit times," and this time study was greatly delayed by having successively the two leading men who had been trained to the work leave because they were offered much larger salaries elsewhere. The study of "unit times" for the yard labor took practically the time of two trained men for two years. Throughout this time the day and piece workers were under entirely separate and distinct management The original foremen continued to manage the day work, and day and piece workers were never allowed to work together. Gradually the day work gang was diminished and the piece workers were increased as one section of work after another was transformed from the former to the latter.[2]

Taylor's later life. Shortly after the beginning of the twentieth century, Taylor withdrew from actively installing management methods and began to philosophize and generalize on his experiences. The far-reaching significance of his principles and method became clear to him and he began the task of transmitting them to others through writings and addresses. His writings of this period have become the very foundation of modern management literature. The first and best known of these is *Shop Management* This book was first published in 1903 under the auspices of The American Society of Mechanical Engineers, having been read at a meeting of the society in June of that year. In December, 1906, Taylor presented as his Presidential Address to the same society his other masterpiece, *The Art of Cutting Metals*. From that time until his death on March 21, 1915, he devoted himself almost completely to the task of spreading the gospel of scientific management.

After Taylor gave up the active practice of management installation, there quickly appeared a number of his direct followers to carry on his active work. These men became known as the "Taylor School" in management work, because their close association with the leader of the movement caused them to be guided largely in their work by Taylor's own methods. At the same time, the influence of Taylor was guiding other men along paths which led to the same goal in distant parts of the United States, and even in other countries. In the hope of finding methods that would avoid some of the pitfalls that befell some of Taylor's detail methods at times, these men developed other methods which frequently seemed far different from those of Taylor. Though the devices differed, the principles, if the work was sound, were Taylor's. In fact, even when opposition to Taylor's work still existed, manufacturing executives who thought themselves opposed to Taylor were in fact following frequently the very lines of thought that were primarily his.

[2] F. W. Taylor, *Shop Management*, Harper and Bros, pp. 48-52

This was due to the wide diffusion of Taylor's principles through his disciples, and also to the fact that his principles were basically sound for the era into which manufacturing was entering.

Taylor's position in the management field is that of the first thorough explorer. His researches, because of his personal ability, carried him further than might have been expected. Unfortunately, he was not a salesman, as far as his own work was concerned. Those close to him were always able to see the careful thought and study behind his conclusions, but others did not have this advantage.

The public, and even a large percentage of factory executives, not excluding the metal trades, did not have their attention focused on scientific management by any of the early work of Taylor or his followers.

Taylor himself was disappointed at the reception of his first paper, *A Piece Rate System,* read before the Society of Mechanical Engineers in 1895. He had used a popular title as a medium of getting fundamental managerial principles before his associates. They remembered the vehicle, but forgot its fundamental concepts. He tried to correct this situation in his later paper, *Shop Management,* read before the same society in 1903. A few of his audience grasped his over-all concept of scientific management, but most of them focused their attention on details, entirely overlooking his basic plea. Although there had been a constant improvement in management methods, and many men were already making management service a life work, in 1910 scientific management had not captured the fancy of any large portion of the industrial world.

Taylor's contribution to wage theory. As intimated above, the current interest of engineering societies during the more formative years of Taylor's industrial life was in segments of managerial activities rather than in "scientific management" as an entity. Wage payment plans held the stage for a season. Taylor evolved a system which was a part of his broader program of managerial controls. His first premise was that no wage plan was equitable either to men or to management unless it was based upon accurate knowledge. He contended that this knowledge was in most instances lacking, but that it was determinable as illustrated by the description of timing pig iron handling. On the assumption that accurate standard tasks have been established, the essence of Taylor's Differential Wage is as follows:

1. Conditions maintained such that the daily task can be accomplished by the worker.
2. High pay for tasks successfully completed.
3. Low pay in case of failure to attain the required task.

His major emphasis was upon carefully establishing tasks and making their attainment possible. This placed a heavy responsibility upon

the executive group, for workers would not long remain silent when they received low pay because of the shortcomings of their bosses. His program provided a high reward as an incentive for the worker to exert himself to accomplish the established task.

Taylor's attitude toward organized labor. In view of recent legislative trends, of our late experience under Section 7a of the National Industrial Recovery Act of 1933, and our current (1940) discussions of the National Labor Relations Act passed by Congress in 1935 and sustained by the Supreme Court in 1937, our treatment of the "scientific management" movement would be incomplete if we did not reveal Taylor's attitude toward collective bargaining. He referred to trade unions on many occasions, and contrary to many erroneous opinions, he was not opposed to organized labor as such. In Taylor's opinion, scientific management removed the need for organized labor, but he said that "there is no reason on earth why there should not be collective bargaining, under scientific management just as under the older type, if the men want it."[3] Taylor specifically sanctioned combinations of workmen, as a matter of necessity to protect their interests, under many situations prevailing in industry. He says, "When employers herd their men together in classes, pay all of each class the same wages, and offer none of them any inducements to work harder or do better than the average, the only remedy for the men lies in combination; and frequently the only possible answer to encroachments on the part of their employers is a strike."[4] He severely criticized certain practices of organized labor such as restriction of output, the use of force or intimidation, and the oppression of non-union workmen. On the other hand, he commends wise union leadership that promotes co-operation naming particularly the Brotherhood of Locomotive Engineers as an example.[5] To summarize, it may be said that Taylor felt that organized labor was necessary under the older type of management, that scientific management removed this necessity, but that there was no logical reason why men should not affiliate with unions of their own choice under scientific management.[6]

The "efficiency men." Modern management shortly came to be known under the term "efficiency" and interest in "efficiency" became so widespread that it nearly caused the death of the management movement. It did retard it. "Efficiency men," fakers in every sense, who

[3] Hearings before Special Committee of the House of Representatives to Investigate the Taylor and Other Systems of Shop Management, Washington, 1912, p. 1444.

[4] Frederick W. Taylor, *Shop Management*, Harper and Bros., New York, 1919, p. 186.

[5] *Ibid.*, p. 188.

[6] See Edward Eyre Hunt, *Scientific Management Since Taylor*, McGraw-Hill Book Company, Inc., New York, 1924, p. 52.

promised short-cuts to profits through panaceas, and whose knowledge of management was as shallow as their vision was narrow, sprang up overnight. They managed to kill the word "efficiency" in American industry most promptly, and they nearly permanently injured the management movement. They failed for various reasons. They usually had no knowledge on which to base their efforts. If they did have the personal experience to qualify them, they usually lacked the broader concepts which would have permitted their work to be successful. They did not pay sufficient attention to the workers' point of view and they did not or would not co-operate with the regular organization. They tried to run roughshod over the older members of the organization until the title of "efficiency man" became everywhere the keyword for concerted opposition, not only from the workers at the bench, but also from the foremen and other minor executives. Recently the "consultant in management," with far different ideals and qualifications, has replaced the "efficiency man," with very effective results. As a matter of fact, the consultant has in recent years so firmly established himself on a deserved professional basis that the term "efficiency" has largely lost the stigma attached to it twenty years ago.

In the general growth of the management movement, the leadership that had been Philadelphia's was largely lost. Sections of the country which were less conservative along lines of management method took to the new ideas more readily and in larger proportions than did Eastern sections. New industries which were developing, such as the automobile and allied industries, had a made-to-measure opportunity to develop management method along with manufacturing technique. These were located mainly in the Middle West. The Middle West grasped the opportunity of increasing effectiveness of operation that was offered by management method, and gradually developed, in many scattered localities, methods of operation which, though built up on the same firm foundations as those that served the early leaders of the management movement, were nevertheless constructed along newer and bolder lines. Of the illustrations of this work, the best known is that of the Ford Motor Company, whose examples of the economies incident to standardized operation, continuous assembly, and newer wage-payment concepts have profoundly influenced the whole of American industry.

The effect of the War (1914-1918) on the management movement. Most of the executives returned to their peace-time tasks with new ideas and new concepts, and, above all, jarred out of the habit of doing things in an accustomed way. They returned to their peace-time tasks with changed attitudes. This, according to Taylor, is the keynote of scientific management: " . . . in its essence, scientific management involves a complete mental revolution on the part of the working man engaged in any

particular establishment or industry—a complete mental revolution on the part of these men as to their duties toward their work, toward their fellow men, and toward their employers. And it involves the equally complete mental revolution on the part of those on the management's side—the foreman, the superintendent, the owner of the business, the board of directors—a complete mental revolution on their part as to their duties toward their fellow workers in the management, toward their workmen, and toward all their daily problems. And without this complete mental revolution on both sides, scientific management does not exist."[7] These men returning to their regular tasks had by no means undergone the complete mental revolution in attitude advocated by Taylor, but they had made much progress in that direction. More had been accomplished in the brief period of war activity than would normally have been achieved in a decade.

The War also broadened the men who had been the very leaders in the scientific management movement prior to the War. They returned to industry with new perspective and vivid recollections of the problems they had encountered with the "human factors" even when functioning under the impetus of patriotic fervor. Greater emphasis on human relations in scientific management was a direct outgrowth of war experiences. This changed attitude on the part of management specialists was in part the result of their intimate contact with men of industry, in part the result of getting into other work for a time, in part the result of the opportunity to try out their theories on a large scale. In any case, management men seemed now to possess a more fundamental concept of their proper position in relation to labor. They now had a feeling of trusteeship of the rights of labor, as well as a trusteeship of the rights of the owners of the business, which they had long felt. Since the War, all those connected with the management movement have been leaders in the development of new concepts of human relations in industry.

The consultant in management. The spread of the management movement has been extremely rapid since the War, and the development has been along what seems to be comparatively sound lines. "Efficiency" has passed on, and in its stead has come soundly developed managerial work that considers the fundamentals of all problems, that is based on broad perspective, and that takes into account the necessities of both booms and depressions. Management has become the profession of the plant executive, not merely the profession of a few who specialize in it. Those who do specialize in management fit into the scheme as specialist co-operators with the managing executives of industry. The consultant in management has become firmly intrenched as one of these specialist

[7] The Taylor Society, *Scientific Management in American Industry*, Harper and Bros., New York, 1929, pp. 9-10.

co-operators. He fills a very real, although a new niche in the halls of industry. He is a combined product of the age of scientific management and the age of specialization in industry. He specializes in management and administration and sells his services, either along general or special lines, to the executive in charge of the enterprise. He brings to one plant the knowledge of many, and he serves to rehabilitate run-down concerns by bringing in the refreshing stimulus of an outside point of view.

Relatively few industrial enterprises are organized in such a way as to have a broadly trained group of men whose sole duty it is to collect facts, analyze these facts, appraise the over-all situation both within and without the enterprise, and give impartial recommendations. Many executives, even the group largely responsible for policy determination, are tied down with managerial responsibilities. Few of them have the time, temperament, or capacity for the objectivity necessary to appraise the results of their own handiwork. Pressing problems arise in enterprises both large and small from time to time that require very special treatment. It is true that in the larger organizations it would be possibe to set up a special department to do the required work; in some of them such a department already exists. Seldom indeed are men with adequate training found within a given organization when it is desired to establish such a department. It usually means that the personnel is recruited mainly from the outside. This takes much time both to secure the men and to weld them into a functioning unit. Where time is an important element, it is nearly always preferable to secure the services of an established professional consulting firm rather than try to establish such a function within the firm. In the case of those firms already having distinct departments established for making surveys and formulating policies, it is seldom indeed that these departments have the wide contacts and thorough knowledge of prevailing practices in similar situations that the outside professional organization possesses. Frequently the regular executive lacks the time to make intensive studies and analyses because of the interruptions of routine affairs. The professional consultant is practically free from the suspicion of prejudice or favoritism frequently present when recommendations are presented by interested parties. He is in a position to state plainly from without certain truths that could not safely be said by members within the organization. The qualified consultant has acquired techniques of working quietly and effectively within an organization without disturbing the routine functioning of the enterprise.

The specialist, or consultant, in management is not the only expert who is a product of recent development in industry. He has come in after the certified public accountant, who occupies practically the same

position in the accounting field as the management consultant in the managerial field, and his advent is not so recent as that of the income-tax expert, whose duties frequently partake more of a legal than an accounting nature. Some of the more recent developments in the field of industrial consulting have become rather specialized. For instance, there is the type of industrial consultant who advises only with regard to the construction of a new building or the remodeling of an old one, specializing in such matters as the type of building construction, fire hazard, or the routing of the product through the factory. There is a still more recent development, the consultant who deals only with labor matters.

Together with the growth of the consultant has come the growth of the "methods man" or "methods department" within the organizations of businesses. This specialist, or department of specialists in management, is continuously on the payroll of the employing concern. The members of the methods department have no particular duties connected with the direct administrative work of the company, but act entirely as specialists in management, advising, and developing new ideas. This group in industry has an important part in the progress that the scientific management movement is making, for they have the advantage of daily contact with the management problems with which they deal. The consultant is of service, even to them, for he brings the experience of many organizations to help in a solution of the problems that confront them.

The future of the management movement. Fortunately, the management movement and its leaders have been able to progress away from the idea that the future of management is bound up inseparably with some particular staff department or some device. The management movement is behind the scientific method of attack on problems of business, but it no longer stands for any particular device or set of devices as being the only scientific method of attack. Staff departments which once seemed inseparably attached to any form of scientific management have been eliminated by some companies in times of financial stress, and still the scientific management method has been used by these companies in attacking their problems. The true scientific approach to the question of development or abandonment of a particular department of a business is the study of the service that such a department might render or has rendered, compared to the cost of its operation. This same comparison, of course, must be expanded to include alternative departments in case departments other than the one under consideration might do the desired work.

Organized labor has become a part of the management movement. "We urge upon management the elimination of waste in production in

order that selling prices may be lower and wages higher." This statement was contained in a resolution adopted at the convention of The American Federation of Labor in 1925. Labor realizes "that its future welfare and best interests are interdependent with industrial progress and business prosperity, and we are placing a distinct emphasis on proposals that will lead to opportunities for co-operation." This is quoted from President William Green of the American Federation of Labor.

A recent statement of policy by the Steel Workers Organizing Committee, C.I.O., shows the attitude of co-operation on the part of a group of labor toward certain aspects of scientific management.

1 The union agrees to co-operate with the management in order to reduce costs, enlarge sales, improve quality and in general to advance the interests of the industry.
2 The management agrees to share equitably with the union any benefits so obtained, in the form of increased employment, better working conditions, increased wages or decreased hours.
3. Nobody is to lose his job as a result of any improvement that is installed. If ways are discovered to do more work with less labor, they are to be put in gradually, and then only with the consent of the union. They must be installed in such a way that no discharges are necessary—as for instance at a time when sales and output are increasing.
4. The research must be truly joint in every respect All facts and plans are to be revealed to the union committee, and its understanding and consent must be obtained at every step.[8]

Surely such expressions coming from both the A.F. of L. and the C.I.O. mean much for the scientific management movement. It will be recalled that organized labor was formerly avowedly opposed to studies to promote efficiency and reduce waste in production.[9]

There are a number of other factors which are combining to insure steady progress for the management movement. Among these are the growth of societies whose membership consists largely of plant executives and whose interests lie entirely with management problems, the increasing literature, both periodical and book, on scientific management subjects, and the attention being devoted by the next generation of factory managers, now in educational institutions, to management as a study.

Just as the growth of scientific education in colleges during the last fifty years has aided in revolutionizing American industry, so the growth of managerial education is likely to aid the management movement in

[8] The Steel Worker's Organizing Committee, *Production Problems*, Publication No. 2, 1938.

[9] See Hearings before Special Committee of the House of Representatives to Investigate The Taylor and Other Systems of Shop Management, 1912.

further revolutionizing it. In 1915 there were not five courses in management given in American universities. Today practically every business and engineering school in the United States is offering courses in management. Although this extremely rapid growth of management instruction has been in response to the demand from industry, yet in many cases, it has led the demand, and has, through its graduates, called the attention of industry to the strides that have been made in management in other sections of the United States. This must be put down as one of the most important developments in management in recent years. Particularly is this true in the instances where industry and the colleges have co-operated in management education, for in practically every case where this has occurred, the combination of practical and theoretical instruction has resulted in distinct advances in the science of management.

PART II

FUNDAMENTAL CONSIDERATIONS IN INDUSTRIAL MANAGEMENT

CHAPTER IV

BASIC MANAGEMENT DECISIONS

The management of a new enterprise, particularly one which is trying to find new customers in a field already crowded, must necessarily differ from the management of a company which has been established for many years, which has its records of the past to look to as a guide, records that will always be productive of much information concerning the steps taken in a given set of circumstances, and which will indicate the success or failure of a large variety of management ideas, some of which have proved to be of great value, others of which, launched with equal hope, have proved exceedingly costly. A company with a fair-sized earned surplus can well afford to try new ideas in sales promotion, in the development or change of products, or the careful study of its productive operations, where a relatively new company, or one that has fallen on evil days from a profit standpoint is unfortunately circumscribed in its ability to make just those management moves involving trial and error which may be most needed to develop it into a strong, able competitor in its field.

Competition in most manufacturing fields is so intense that there are not many dollars to be saved from the better prices at which materials can be secured. Dollars cannot usually be saved in the wage bill by securing inferior workmen or paying them wages materially under the market rate. The best machines are usually the newest, and although they may save from a third to several times their original cost in a single year, compared to old machines and methods, new machines are costly, and only those companies with adequate funds can expect to be able to stay at the head of their particular process by the replacement of worn-out and out-of-date equipment. That is, unless they have the spark of genius in management. Many an enterprise has been brought back from the depths of operating losses that were threatening

to submerge it to a sound profitable operating basis, not by the performing of any management miracles, but just by the day-to-day genius of a real organizer who not only cut corners in costs that had no permanent place in the company, but who welded together the loose ends that had developed and made of them an operating whole.

Size. With these thoughts in mind, how large should a chief executive or his Board of Directors allow a business to become? Manifestly there can be no one rule. Even the smallest unit now existent in the automobile industry would be a tremendously large unit in almost any branch of the textile industry, while a company manufacturing automobile parts should be prepared to produce the requirements of at least one of the automobile manufacturers if it is to survive today, and yet it must have at least enough additional business to prevent it from being put out of existence by losing its one large contract. Likewise, it should diversify its line sufficiently to prevent its being put in a dangerous situation by a quick switch of its market away from the type of part it manufactures.

The best rule that can be suggested concerning size is that a size be maintained that will always leave the company liquid from the standpoint of working capital, that will enable it to keep up with product developments in its field, and that will be a unit sufficiently large enough to influence the trend of products and style in its field. If it be not large enough for this, it will be in the dangerous position of having to follow the lead of its important competitors, and possibly run the danger of seeing an investment in machinery and equipment wiped out almost overnight by sudden trends away from its product.

Once a company becomes successful, there is always the urge to expand the manufacturing facilities in good times to meet possible sales. Fine judgment is required to know how far facilities can be safely increased, and when the decision should be made to sell only so much as the present plant can produce or as can be safely contracted out for manufacture. A closely knit organization which has been successful in building a business because of the close contacts and understanding that lie between its respective members may become overstrained and buckle if given the task of operating a much larger business where the personal touch is not of the same importance as carefully laid and integrated organization plans. There is a particularly big jump between a business sufficiently small for one man to oversee all the details, and a business so large that one man is unable to keep in touch with all its details.

An interesting announced policy with reference to size of a business is to be found in the policy of the Royal Metal Manufacturing Company of Chicago. President Irving Solomon of this company has said,

"Sales of Royal Furniture are purposely limited to $1,500,000 annually. Reasons: This permits the president personally to watch quality; to know each worker by name; salesmen are not harassed by constantly rising quotas, not high-pressuring unwilling buyers. If dealers cannot supply, buy from Royal's worthy competitors."[1] In another national advertisement the Royal Metal Manufacturing Company actually named six of its competitors from whom it recommended that customers buy in case the stated policy of the company did not make possible the filling of all the customers' requirements. This policy is unique in the annals of American business, at least as far as public announcement is concerned, yet it is one that requires a definite decision on the part of many executives.

Buy or make parts and materials? One of the basic management decisions which must be met throughout the life of a manufacturing business is whether certain parts or raw materials should be manufactured in the plant, completely controlled by the company, or whether they should be purchased on the outside to specification. How completely should the business be integrated? Recognizing the profit aspects of a completely integrated business, there are, nevertheless, many dangers incident to making materials, or parts which can be bought as cheaply, or almost as cheaply, as they can be made. Some of the factors involved are:

Why parts can be bought more cheaply

1. Occasionally advantage can be taken of depression conditions to buy at less than the full cost of manufacture, including interest on investment and depreciation. This is particularly true in articles where the field is highly competitive.
2. The processes incident to the manufacture of the part are often foreign to the remainder of the business.
3. There may be greater chance of obsolescence in the machinery needed to manufacture the part than in the remainder of the process. In such cases it may be advantageous to allow another manufacturer to own such machinery.
4. The requirements of the business for the part or material may be only a small fraction of the total requirements for the material from other dissimilar businesses. Such a condition will give the independent manufacturer the advantage of others' large-scale purchases for his requirements.
5. At any given time, the extent of capital available to a given business may make it more profitable for that business to utilize that capital in sales and other business promotional or research activities, rather than to tie it up in machinery and materials for the manufacture of portions of the product which can be purchased.

[1] Advertisement in *Time*, Nov. 10, 1936. (As we go to press, President Solomon states that he is still following the same basic policy.)

Why parts should be made

1. During times of prosperity, particularly in cases where a certain product has taken the fancy of the buying public, it is sometimes difficult to secure prompt deliveries on rapidly rising requirements from usual sources of supply, and at such times new sources are difficult to develop with sufficient rapidity.
2. Processes into which hidden quality is put and which have much to do with the acceptance of a particular article can be more satisfactorily made by the company responsible for the quality guarantee.
3. On style merchandise, parts or materials which give clues to the appearance of articles to be made for a particular season sometimes may better be kept from competitors as long as possible.
4. Particularly in large companies, the policy has been adopted of manufacturing a portion of the most important parts in order to have a continuing yardstick concerning the proper cost of such parts, and also as a means of preventing suppliers from arbitrarily increasing price in times of greatest need.[2] Similar effects have been secured time and again by threatening to go into the manufacture of some purchased part; often long-time contracts at favorable prices having been secured by this means.

It should not be inferred that a decision once made to manufacture or to purchase must remain unchanged. As conditions within or without the enterprise change the decision should be reappraised in the light of the new situation.

Quality of product price-field. A fundamental decision which must be made by most manufacturers early in their existence, and reconsidered frequently, is the price field in which they desire their product to compete. Not only will the decision which they make in this regard influence the basic quality of their product or products, but it will doubtless profoundly influence both their manufacturing methods, machines and personnel, and their basic methods of distribution. Lower-grade, volume products generally must be distributed on a wider, more inclusive scale than medium- or high-grade products. Profits per unit will be much smaller, but in so-called volume products the potential sales outlets are so much larger that their attractiveness lies in the greater potential profits which exist in most fields with this class of merchandise. However, the greater potential profits bring with them at least three added problems; namely, (1) more intense competition, (2) price pressure from distributors and dealers, often to the exclusion of regard for intrinsic merit of the article, (3) the costs of added plant and equipment if the article

[2] This also has the effect of letting the manufacturer's department operate at full capacity at practically all times, leaving the irregular overflow to the company from which parts are purchased.

is favorably received. This becomes increasingly difficult if the demand for the article be transitory.

It is difficult for management to resist the siren call of the distributor or dealer who wants the low-priced merchandise. Frequently this is asked for "as a leader," with the assurance that there is no intention to push the low-priced merchandise, but only to use it as a means of attracting customers, after which they will be gently led toward the merchandise of higher grade, with higher percentages of profit. It is with assurance of this kind from distributors and dealers that many manufacturers have been led to produce merchandise selling for a considerable percentage under anything which they have previously produced, only to find that once the snowball was started it could not be stopped, that the market has come to be educated to the new low prices as being the proper amount to pay for the article of the type, that a large proportion, if not a majority of the sales are being made in the new low-price brackets, with accompanying low profit-margins, and that a whole new advertising and sales promotion campaign are necessary to bring public acceptance back to the higher-priced merchandise.

Thus the price field which a particular manufacturer will attack, or if he be going to attack several price fields, the relative extent of each, becomes a problem which has to be considered continuously and becomes one of the basic factors in management. The type of sales outlet to be used may govern the decision, and conversely the decision may be governed by the type of outlet. An example will illustrate. A manufacturer of gas stoves has a choice of several methods of distribution or combinations of them, as follows:

1. Through public utility companies.
2. Through a distributor organization, with distributors utilizing specialty stores and hardware stores as outlets.
3. Through department stores, which ordinarily will not buy through distributors, but wish to buy direct from the factory.
4. Through large stove stores in some cities, which ordinarily buy as do the department stores, but which may also act as distributors in their section.

Some of these outlets cannot be satisfactorily used competitively within the same district, because of their divergent merchandising policies. In some cases it does not prove practical even to sell through several types of merchandising agencies, even in widely separate districts. Such is generally the case in sale through public utilities and department stores. The reason is that the type of merchandise that they demand and the type of sales promotion methods which they use are usually different. The department store has a series of sales scattered throughout the year, with which to attract customers to the store, with unusual

offerings in the way of price as the particular inducement. For these sales the store must secure from the manufacturer "specials," which will be only slightly different in design and grade from regular merchandise, but which patently must present values that will immediately prove to be outstanding to the customer, both in attracting him to the store, and in effecting sales after he has been brought in. There are only a few department stores which can successfully, over a period of years, promote the sale of the more expensive, most completely equipped gas stoves. These have been distributed most successfully either through the public utility companies, the stove stores, or distributors.

The decision to distribute direct or through distributors, with any product is determined by a number of factors other than the quality of the product. Some products can be most successfully distributed through distributors. Other products may be sold to retailers, while still others may be sold direct to the consumer. The custom in the trade will exert an influence; a strong organization, however, may establish its own custom. There is some difference to be considered between marketing a heavy producer's goods and a widely used consumer's product. The former may require a highly specialized technical knowledge not readily available among the usual distributors. Almost any product that one can name, however, has more than one channel of distribution, largely depending upon the managerial decisions of the particular enterprise. Such items as availability of funds, availability of desirable outlets, credit policies, etc., may be immediately controlling.

Diversity of product. A management decision which must be constantly faced is the number of different types of products which the company shall manufacture. This is a different and more fundamental problem than the extent of diversity in products of a given type, considered under "Simplification" in Chapter XV. It is a decision concerning the number of fields of industry in which the company should engage. Companies with large financial resources have shown tendencies in recent years to invest these in manufacturing products in related fields, particularly if they can be distributed through the same outlets; but other companies have felt that their own future could best be assured by spreading their activities over widely divergent fields which would tend to assure them profits if their original field was slack, and would give them the opportunity to utilize the managerial brains and experience which they had developed to produce additional profits for their stockholders beyond anything that might be possible in the field of their original interest. The development of General Motors from a corporation having only automobile manufacture as its interest, through a corporation having parts and allied products added to its interests, to a corporation having large diversified interests is a case in point. This

corporation, in addition to its automotive divisions, covering the field from the lowest to the highest priced car, and its ignition, lamp, starter, foundry, gear, axle, and other plants, has entered into a commanding position in the electric refrigerator, electric motor (for both domestic and industrial use), diesel engine, air conditioning, and railroad equipment fields. More recently the Kelvinator and Nash corporations have combined their manufacturing and marketing interests. It is by no means a settled question that this type of expansion to get diversity is entirely advantageous. In many instances after a certain size has been reached, economies derived from further expansion are open to serious question. Strong individual producers are still succeeding in practically all the fields that have been entered by these larger corporations.

How far should the relatively small company with capital only sufficient for its immediate needs venture toward the diversity of product? This is a decision which cannot be made merely by copying the example of the large aggregations of capital, even though it becomes industrially more dangerous year by year to have all one's eggs in one basket. Should a company with a moderately successful experience over a period of years in the manufacture of polyphase electric motors for industrial use invest a portion of its accumulated surplus in endeavoring to wrest a portion of the attractive household electric-refrigerating motor business from its more powerful competitors? It may have the technical and managerial skill to produce this new line of motors, even though they be single-phase and all its experience has been with polyphase. Questions that its directing heads will have to ask themselves include:

1. Do we have something to offer in an improved product which will cause the large accounts to buy from us instead of from the better-known and larger producers?

2. If our product be just as good, or a little better, will we not have to sell it cheaper than our larger competitors in order to secure a portion of the business, and if we do that, will not our competitors, with their greater financial resources, drive down the price still further, so that it will be unprofitable business for us?

3. Are we certain that our engineering ability will give us products which will stand up in quantity manufacture so that hidden defects in our first year's production will not cause large quantities of these high-production motors to be returned to us under our guarantee? If this happens, have we the financial resources to withstand one such setback?

4. Would not the amount of managerial and sales effort necessary to secure a portion of this new business be better expended in improving and enlarging our field of sales in the type of product which we have always made, and which we fully understand?

5. If we secure the business of several of the smaller refrigerator

manufacturers, but are unable to secure any of the business of any of the larger ones, will the profits available from such business offset the costs of tooling up and doing the experimental work necessary to enter this field?

The questions set forth in the example just given are not intended to be inclusive, merely suggestive. How much more must the executives of a company question themselves when they are thinking of diversifying their product into entirely unrelated fields, even though much of the productive work on the new product can be done on the same machines that are already in use. Truly there is no substitute for ample funds with which to rectify mistakes and bridge over lean years when diversifying. These management problems help us to understand why large corporations are those most successful in consolidating units making diverse products, and point to the fact that properly developed consolidations between two or more small companies are frequently more successful than attempts to expand the number of lines of products However, it is fairly well established that a diversity of products, either through consolidation or otherwise, brings problems of managerial control that require careful decisions regarding organization and policy.

Decisions relative to financing. One of the first decisions that must be made at the inception of an enterprise is the method of raising the necessary funds to take care of the first few years of operation. This may be accomplished by the sale of common stock, preferred stock, bonds, some short-term borrowing for seasonal needs, and other methods known to students of corporate finance. The fact that adequate funds are raised in the beginning does not settle this important item for all time. Should the enterprise prosper it is quite possible that new plants, buildings, and equipment as well as working capital will be needed to care for the increased business. Even though adequate funds be available from operating profits, a decision is required as to whether or not these funds are to be reinvested, or distributed to the stockholders and the needed funds raised by selling additional stock or other securities. There is also the question of the extension of credit to customers which is basically one of finance. Again, profits may be high during a period of prosperity and management may be forced to decide whether or not to distribute these profits as earned or to establish a policy of paying a moderate dividend during prosperous operations and thus build up a surplus with which to pay a dividend during lean periods. There are many other types of decisions that management will be forced to make of a financial nature such as whether or not to carry its own workmen's compensation insurance, the question of profit-sharing with employees, whether or not to bear a part or all the group employee insurance, the establishing of an annual wage, management profit-sharing, credit policies,

etc. Many of these involve factors other than finance, but they all are also financial in nature. A decision once made may not be final.

Plant location. The decision regarding plant location when coupled with the decision to buy or build the plant buildings is of far-reaching consequence. Such a decision involves large commitments of a relatively permanent nature and definitely reduces the ease with which the enterprise can adjust to changing conditions. Plant location is both influenced by and influences the nature of the product manufactured. Plant location also influences the nature of the organization. The economic and organizational features of plant location are of such importance that they will be explored in greater detail in the following chapter.

Managerial standards. In no place are managerial decisions given the acid test more rigidly than in the establishing of standards. Managerial standards are basically the crystallization of managerial policies into formal measures and procedures. Managerial standards cover the entire range of business activity, finance, accounting, quality of product, organizational structure and procedures, requirements of divisional and departmental performance, executive remuneration in relation to profits, worker profit-sharing where it exists, purchasing, selling, etc. An effective standard can be established only after careful investigation, analysis, a consideration of the objective to be attained, a harmonizing of conflicting interests, and agreement upon the basis of measurement. Temporary standards may at times have to be established in the absence of all the necessary facts or where time does not permit the harmonizing of interests or agreement upon the common measure. Such temporary standards, when established by persons having a broad background and keen insight, may develop into permanent standards when supported by experience. Standards act as stabilizers of activities and relationships. They relieve management of the responsibility of caring for many details and enable them to concentrate on problems that have not as yet been solved. The details of standards are discussed under the respective specialized chapters, such as equipment, product design, time and motion study, etc. It is important, however, in the consideration of management decisions to observe that management standards are the basis upon which all other detailed standards are based. In the absence of seasoned managerial standards, departmental or functional standards are largely ineffective.

CHAPTER V

PLANT LOCATION

Scientific determination of plant location can seldom be accomplished on a mathematical basis. It is often the result of a compromise between conflicting social, economic, governmental interests and geographic considerations. Personal desires of the owners or managers, often influenced by social considerations, may suggest one location when economic considerations would indicate another. In smaller enterprises the social considerations frequently are determinative unless the economic disparity is too great. In the larger, more impersonal corporations where the policy-determining officers are centrally located in some city the location of a given plant unit usually is determined largely on its economic merits, yet even under such circumstances social factors are also considered. Governmental factors are not so important in many instances, but they assume greater importance if the company desires to engage in foreign trade. Geographic factors are both regional and local.

Regional specialization. Climatic conditions, natural resources, the general nature of the terrain, and the cultural heritage of the people are influences that explain in part regional specialization. Certain types of manufacture such as the textile industry require an atmosphere having a high relative humidity. The New England States possessed this natural condition which encouraged the development of the textile industry in this region. Recent developments in artificial air-conditioning have taken away this advantage to a large extent. Coal can be mined only where nature has deposited it, and large consumers of coal for fuel or as a material from which products are derived are naturally located as near the source of supply as the other economic factors permit. Natural mediums of transportation such as rivers, lakes, and the ocean have throughout the ages been influential in the location of cities through which commercial traffic passes. Wherever an abundant labor supply exists there are conditions favorable to industrial specialization, especially if there exists concurrently a cultural heritage of the people that is in harmony with the specialization. If there be added to the abundant labor supply and favorable cultural heritage the fortuitous circumstances of an early start, industrial specialization logically follows. On this basis regional specialization in American manufacture is largely ex-

plained. It is not quite so easy to explain just why an early start for a particular industry should have been in one place or a few places except on the basis of leadership, and leadership is not always easy to break down into its elements. The willingness of the people in a given community to invest their funds in an untried enterprise is frequently as important as inventive genius. The Chamber of Commerce of Detroit encouraged the building of automobile plants in that city.

Other illustrations of regional specialization in industry are pottery manufacture in Trenton, New Jersey, and East Liverpool, Ohio; brass manufacturing in the Naugatuck Valley of Connecticut; the rubber industry in Akron, Ohio; agricultural implements in Chicago; firearms and fine tools in Connecticut, steel in Pennsylvania, Ohio, and the Great Lakes region; carpets in Pennsylvania; and the scientific optical glass industry in Rochester, New York.

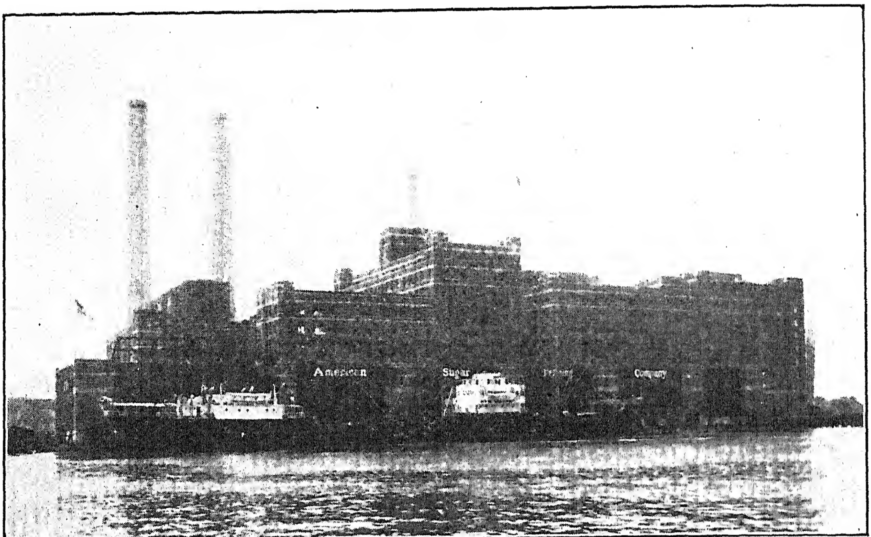
Major factors in plant location. The major factors in regional *plant location* are: (1) nearness to the desired market; (2) the local and regional tax situation, (3) nearness to the source of raw material; (4) an adequate supply of labor; (5) transportation facilities; (6) climatic conditions; (7) governmental factors; and (8) the availability of water, power, and fuel.

The primary factors in determining the *exact location* or site within a given area include: (1) the availability of land to meet current requirements and future expansion needs as well as the relative cost of this land in comparison with other cost factors; (2) the nearness of other industries upon which the given plant may be dependent; (3) transportation facilities for raw materials, finished products, and employees; (4) availability and characteristics of the labor supply; (5) importance of the local market; and (6) community restrictions and in some instances community aids.

Regional location refers to the major area in which a plant is located. A plant manufacturing a product to be marketed in the upper Mississippi Valley and the Great Lakes region might well consider the Chicago area although several locations within a radius of seventy-five miles would meet the regional requirements. Nearness to the market, definitely tied in with the transportation problem, is also influenced by the question of the time element in giving prompt service, technical advice, and in the ability to adjust to the trends in the given area. The labor supply, particularly for a small enterprise, is usually more satisfactory in or near a city. Nearness to the source of raw materials is of special importance when the raw material is bulky in relation to the value and when the volume and weight are greatly reduced during the processing. If the volume of the raw material is small in comparison to the volume of the finished product the plant will usually locate near the market instead of

near the raw material supply. Raw materials that are rendered less perishable by the manufacturing process are nearly always processed near their source. Climatic conditions for manufacturing operations are not as influential as formerly due to modern air conditioning techniques.

Transportation facilities and costs may dictate one location of a plant when the other factors would be strongly in favor of another location. Water transportation nearly always costs less to the consumer than rail or truck transportation. Henry Ford has located many of his assembly plants on navigable waters. This is a common practice when possible for industries having large volumes of freight. (See



Courtesy, Stone & Webster, Inc.

FIG. 1. The American Sugar Refining Company, Baltimore, Md.

Fig. 1.) A region that has adequate rail, water, and truck transportation is definitely to be preferred for the manufacture of a product for a large market. The size of a given market that can be economically served by an individual plant is greatly influenced by transportation rates. As far as transportation is concerned, *plants tend to be located in that locality where the aggregate transportation costs are the least.*[1]

Governmental factors are important from a regulatory and licensing standpoint. Taxes must also be considered. State prohibition laws have in the past influenced the location of distilleries. Certain states

[1] See D. Philip Locklin, *Economics of Transportation*, Business Publications, Inc., Chicago, 1935, p. 114.

still have discriminatory legislation regarding alcoholic beverages. Many industries manufacturing for export have established branch plants in Canada to gain the advantage of a favorable tariff in the United Kingdom.

After the decision is made to locate a plant in a given region, the selection of an exact site is influenced by the factors listed above. The availability of land to meet current requirements and future expansion needs is always important. The manufacturing process may be more easily handled in a single-story building This will require a larger area. If land values are too high less land space will be used and the structure will have to be a compromise and go up in the air. Provision for expansion is important and often results in great economies in later development.

An industry that uses a by-product of another plant as its raw material or is a service plant to other plants naturally should be located in so far as is possible in the vicinity of the other plant or plants. This reduces freight charges and improves the service rendered.

Local transportation for raw materials may be handled by truck if the volume be relatively small, yet even in such cases rail and water transportation is often advantageous. Transportation facilities for employees or nearness to the homes of employees may reflect itself in the labor expense as well as in the character of the labor available. Many employees use their own automobiles, but this method of transportation requires parking space which is often prohibitive in high-priced land areas. Transportation costs and nearness to homes of the workers are particularly important for industries using large numbers of common laborers.

The local market is of minor importance to the large-scale manufacturer having a wide distribution of its product. It is important, however, to the small manufacturer and the manufacturers of bakery goods, perishable food products, etc.

Community restrictions such as requirements for the disposition of wastes, smoke regulations, and zoning restrictions are often controlling. From the standpoint of other factors, a restricted area may be a desirable location for a plant, yet it is reserved for residential purposes. It is nearly always unwise for an industry in its capacity as a good citizen to try to break down community regulations even though it proceed through regular channels.

Advantages and disadvantages of specialized communities. Given an area in which a factory may locate because of the influence of the major locating factors, the selection of a specialized center within that area is always a distinct advantage. Management problems are simplified in a variety of ways by a plant location near other similar indus-

tries. Not only is there a trained labor supply available in such localities, but the ease of financing the business and selling the product is enormously increased. Examples of this are found in Minneapolis flour milling, cotton spinning in the manufacturing districts of the South, automobile manufacturing in Detroit, and rubber manufacturing in Akron.

The banks in such communities are familiar with the needs of the business, have a knowledge of good business practice in the industry, and usually are willing, to the limit of their ability, to aid in any legitimate way. Other industries located in one-industry communities, conversely, frequently find it extremely difficult to secure the co-operation of the bankers in handling their own accounts properly. Sometimes they are even forced to go out of town for accommodation in times of extreme need.

Buyers gravitate to localities in which an industry is centered. Sometimes, indeed, a dominating market can be established in the town in which the goods are manufactured. Thus, the periodic furniture expositions of Grand Rapids attract buyers of high-grade furniture from all over the United States.

Another benefit of a location in a specialized community is the proximity of machinery manufacturers who make the type of equipment that is used in the industry. Required machinery can be procured on short notice, and more important, repairs to machinery can be secured quickly. If the machinery manufacturer himself is not represented in the specialized center, it is probable that repair shops will soon spring up. This appeals particularly to companies which are not large enough to maintain their own repair departments.

Other factors have caused problems to arise in some industries which have in the past caused some manufacturers to move outside the specialized center. Specialization within an area facilitates the unionization of labor within the industry. Those manufacturers who do not desire to employ union labor have found this a cause for moving outside the area. Other manufacturers who are not opposed to dealing with unions have moved their plants because of an unfavorable labor situation in some specialized communities. Specialization within a community leads to much "shopping around" by purchasing agents in times of depression, and thereby the fact that they come to the market to buy is not an unmixed blessing to the manufacturer.

Location advantages of the large city, the small town, and the suburb. A plant may locate in a specialized section and still have a choice of a large city, a small town, or a suburb of a large city. Such a choice is to be found particularly in such sections as the shoe region of New England, or the automobile regions of Ohio and Michigan.

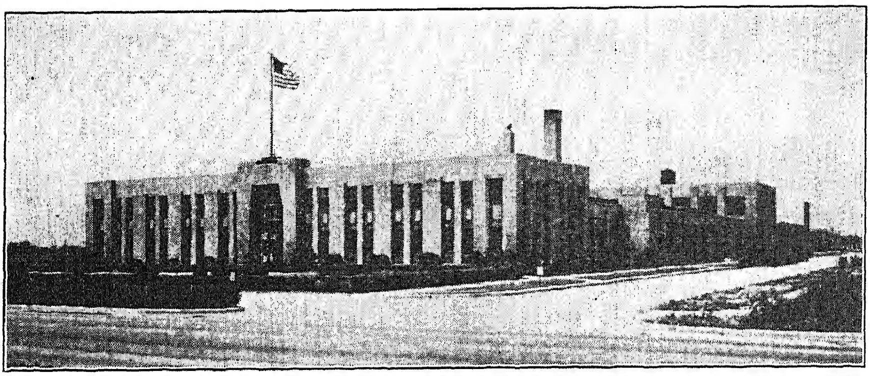
If the specialized area be a great city, many of the advantages of the location within that city can be gained by a location near by, while at the same time some of its disadvantages may be avoided. Thus the automotive plants of Pontiac, Flint, and Jackson, Michigan, have most of the advantages of those located in Detroit, while at the same time they are not faced with the transportation problems or the taxes incident to location within Detroit. The tax problem has played a major role in locating new plants that are branches of larger parent organizations. Pontiac and other "satellite" cities owe their industrial growth largely to the high taxes of the larger cities. This tax differential tends to disappear with the passage of time and the growth of these satellite cities.

Advantages and disadvantages of the big-city location. The big-city location has its distinct advantages. Most of the advantages of the specialized regions are to be found here, and found in greater abundance than elsewhere. Besides, there are unusual educational and amusement advantages. Not only are there the educational advantages for the children of the employees, which may make the employees desirous of being in the larger town, but more especially there are trade and industrial educational advantages. Evening schools for the workers, which make them more valuable to their concern and to themselves; discussion groups for the executives, such as advertising clubs, production, and engineering organizations; foremen's training classes, and many other types of modern industrial educational opportunities are to be found in the big city. They represent a real reason for locating in the city rather than in the small town. These advantages can also be enjoyed by the firm that is located in the suburbs, provided the transportation facilities are good

Not the least of the big-city advantages is the fact that, even in specialized communities, there is always available a more diversified working-force than is the case in smaller communities. It is nearly always possible to secure male or female labor, as is desired. Of course, specialized communities that employ only male labor always tend to build up complementary industries employing women, regardless of the size of the community. The advantages of big-city location are offset by disadvantages, in the eyes of many industrial executives. For instance, the small plant is likely to be at a disadvantage in a big city because it is forced to find a location in a loft building. Though this type of factory building is particularly common in New York, it will be found also in almost every large manufacturing city. The loft building is the refuge of the man who seeks to take advantage of a labor supply near at hand, as in the clothing trade of downtown New York, or the textile industries of northeast Philadelphia. The loft building makes difficult the development of modern management not only in the com-

pany that uses it, but in the whole industry near by. It is difficult to maintain working standards against the type of manufacturing competition that rents a floor, rents machines, forgets the existence of overhead, and proceeds to make hay during the sunny times of industry.

Some years ago there was a tendency to locate big-city plants in the center of a thickly settled manufacturing district, where ground was expensive, future expansion difficult, and attractive settings were almost impossible. With the development of high-speed transportation within great cities this condition has changed, and within the boundaries of these cities new plants are locating under conditions which approximate suburban location. In fact, arbitrary boundary lines are frequently the only difference between city plants and suburban plants now. (See



Courtesy Petrolagar Laboratories, Inc.

FIG. 2. Petrolagar Laboratories, Inc., Plant, Chicago.

Fig. 2.) In medium-sized cities, attractive settings have always been possible, as at the plants of the Eastman Kodak Company in Rochester, New York, and the National Cash Register Company of Dayton, Ohio.

To summarize, the advantages and disadvantages of the big-city location for a plant may be said to be:

A. Advantages.
  1. Trunk line rail and water transportation most likely to be available.
  2. Adequate supply of labor.
  3. Presence of subsidiary, service, and related industries.
  4. Financing of the enterprise is often easier.
  5. Large local market for product, of particular importance to the small plant.
  6. Social and educational advantages for employees and executives usually very extensive.

B. Disadvantages.
1. Scarcity of available sites that provide room for expansion, and expensiveness of the land.
2. High taxes.
3. High labor costs, since living costs and wages are usually higher in large cities than in smaller ones in the same region.
4. Labor relations at times less friendly in larger cities than in small communities.

Advantages and disadvantages of the small-town plant location. Many of the advantages of the big city are lacking in the small town. A diversified labor supply, amusements, and other features are usually lacking in greater or less degree. It is an important fact that the high-grade executives tend to locate near the larger cities.

The small town does offer certain very definite inducements that the large city cannot give. The supply of land suitable for constructing a plant to meet the present requirements with ample room for expansion is available. Undesirable manufacturing neighbors are not likely to be present. Municipal regulations are seldom burdensome. Low taxes, coupled with definite rebate of taxes in some cases is another factor. Many small towns give free land, or even erect buildings and give bonuses to large industries to locate within their borders. There is a real danger in placing too much emphasis on such factors if more basic conditions are not advantageous.

Although small towns do not have a diversified labor supply, and although trained labor for a new industry usually is absent, this is partially counterbalanced by the fact that the town's industries are not likely to absorb the total available labor supply of the community. This has become particularly true since women have entered so extensively into industry. In general the labor relations between employers and employees are favorable in the small community at least in the early stages of the plant's development, and usually continue when the management follows an enlightened labor policy. While the labor supply is untrained, it is more easily trained in the technique of a given industry than is labor in a large city, because the absence of alternative opportunity makes the workers desirous of learning.

Adequate housing facilities may be lacking in the small town to care for the employees of a large plant. To care for this situation the industry may have to foster a housing program, as is discussed below.

Suburban location. The type of location which provides most of the advantages of both the big city and the small outlying town is the suburban location near the big city. This accounts for the very rapid development of the "metropolitan districts" near large industrial centers

during recent years. The one-story structure is here possible. The inducements are sometimes offered by the suburban community too; at least the ground is cheap and the taxes are relatively low. The advantages of the big city near by are usually to be had by all the staff sufficiently often to keep them contented, particularly if the housing conditions in the suburb are as good as, or better than in the city. Railroad facilities in the suburbs are usually as good as they are in the city. In fact, they are likely to be better, in that spur tracks are easier to secure and they can be arranged to suit the needs of the plant. All the advantages of having several competing railroad lines, which are usually found in a large city, may be had, and where this is the case, dependence upon one railroad company, which is often the bane of the small-town manufacturer's existence, would not be faced. There is practically no disadvantage that can be named for the suburban location.

The economic survey as a basis for plant location. Chance and the many other similar factors that have influenced the present location of many industrial plants are giving way to more accurate scientific determination of the most desirable location for a given plant. Industrial engineers and market analysts have developed techniques for determining with a fair measure of accuracy the volume of business that may reasonably be expected from a given market area, and the plant location that will make possible the delivery of the product to the consumer in this area at the lowest unit cost. That plant location *is best which results in the lowest unit cost in producing and distributing the product to the consumer.*[2] It is seldom controlled by one factor alone but is usually the resultant of many economic forces.[3] It includes: (1) incoming freight expenses, (2) cost of fuel, power, and water, (3) cost of the plant site, (4) building costs, (5) labor costs, (6) freight costs for the finished product to the consumer, etc. With these costs and assumed volume of production, an operating statement can be constructed or a cost analysis made that will indicate certain definite preferences as to location.[4] Most of the data required are readily obtainable from current prices and published schedules for the communities under consideration. Labor costs are usually computed on the basis of the prevailing rates in the community for common labor. Land sites can usually be determined locally by an actual bid or offer. The nature of the land site

[2] See W. Gerald Holmes, *Plant Location,* McGraw-Hill Book Co., New York, 1930, p. 3.

[3] *Ibid.*

[4] See Eugene L. Grant, *Principles of Engineering Economy,* The Ronald Press Company, New York, 1938, pp 126-129, for an illustrative computation of relative costs for various locations; also William B. Cornell, *Organization and Management in Industry and Business.* The Ronald Press Company, New York, 1936, p. 178.

may determine to some extent the building costs. Labor rates, a large factor in building construction, vary considerably in different localities.

Such a survey frequently shows that the large city offers special advantages to the small plant, that the suburbs of a large or medium-sized city are best suited to the fair-sized plant; and that small-town or rural location has much to offer the very large plant that is in a position to attract to it its labor supply and is able to aid in the housing situation. This is a very broad generalization to which there are innumerable exceptions. Each individual situation should be analyzed in terms of its peculiar needs and requirements.

Trends in decentralization of industry. Decentralization in industry is a term that has gripped public attention recently but one that has been used rather loosely.[5] For many years in American industry plants tended to grow in size, partly influenced by economies in mass production and partly from the American attitude toward "size." Building plants away from the home plant to care for needed productive capacity in a strict sense is not decentralization but rather a change in the trend toward increased centralization. The transfer of production to outlying plants, thereby decreasing not only relatively, but actually, the production in the central plant, constitutes decentralization. Much of the geographical shifting of production involves in reality enlarged or increased production in areas hitherto not actively engaged in this type of production, rather than a decrease in the actual production in the old plant or area. Since the older production areas and plants may not be increasing production at the former rate, opportunity for the increasing population in this area to find employment is not as favorable as formerly. This situation naturally raises grave social, economic, and governmental problems. Manufacturing tends to follow the shift in population and population tends to increase in manufacturing centers, thus establishing a reciprocal relationship. Both population and manufacturing centers tend to follow economic opportunities closely related to the abundance of natural resources.[6]

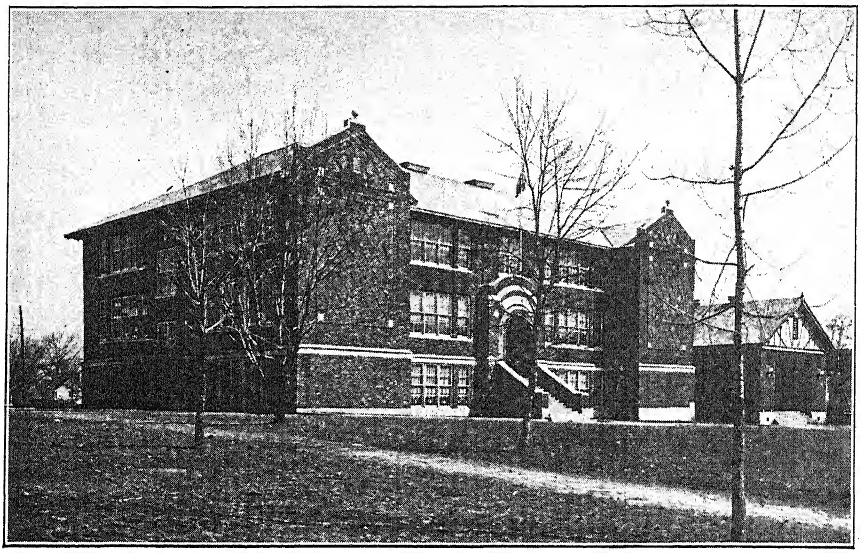
Other factors influencing the growth of industries in new regions (which is the idea in the minds of many people when they speak of decentralization) are: (1) favorable labor legislation or labor relations in the new area; (2) lower labor costs; (3) nearness to the source of raw materials; (4) cheap electric power (T.V.A. region); (5) lower taxes; (6) special inducements in the form of free land sites, etc. Some manu-

[5] See William N Mitchell, *Organization and Management of Production*, McGraw-Hill Book Co, Inc, New York, 1939, Chapter IV, for a scholarly discussion of "Regional Organization of Production," especially pp 62-69.

[6] The population center of the United States according to the 1920 Census is near Whitehall, Indiana.

facturers think that there are long-run social and economic advantages in having industry more widely distributed than was the trend at the beginning of the twentieth century. There is little likelihood that a large number of widely scattered, self-contained small industrial units will develop. It is more probable that the next step in the evolution of regional plant location will be a highly integrated system of plants decentralized as to process but directed by a unified management. The location of the manufacture of steel has to a large extent followed its market. Pittsburgh is still a large producer of steel but so also are Chicago, Detroit, and Cleveland.

Industrial housing. The industrial town is best known to the public through its development in the remote mining camp of the West or in



Courtesy J. E. Sirrine, Co., Greenville, S. C.

FIG. 3. School at Pelzer Mfg. Co., Pelzer, S. C.

the coal-mining regions of the East. Most of the publicity that it has received has not been favorable, and there is a prejudice against industrial towns which must be overcome by the individual company. Early attempts in the construction of industrial towns were largely failures because they were built on a paternalistic concept which was unsound.

The company has a proper interest in the living conditions of its employees, provided that it does not carry that interest to paternalistic extremes. The worker who is in a plant for an eight-hour day is there only about one-quarter of the year. Everyone is agreed that conditions

in the plant affect the workers' health. If this is true, how much more must their health be affected by conditions in the home. Health and production are directly related. Furthermore, the costs of changing employees continuously will be decreased if the employee can live in a better home when working for a particular company. The cost of replacing employees may be found to be larger than the interest rates on the money that a company may tie up in an industrial housing project.

Henry P. Kendall, of Kendall Mills, Inc., with extensive interests in the South, has said, "Streets are resurfaced, sidewalks built, landscape gardening begun, and workers' dwellings remodeled and equipped with baths and other conveniences. Churches are repaired and painted, or perhaps built, and facilities of entertainment are introduced".[7] Fine schools have been built as a part of such factory villages. (See Fig. 3.)

Industrial houses may be company-owned, and may pass into the hands of the worker through the financial assistance of the company, or may be owned by a separate corporation, in turn owned by employer and employees. For the company to own permanently a large share of the houses in a town or village is likely to result in the abuses that have brought condemnation upon industrial housing projects in the past. One of the first two types of ownership is more successful, particularly in older manufacturing communities.

[7] Bulletin of the Taylor Society, Dec 1927, p. 524

CHAPTER VI

ORGANIZATION DEVELOPMENT

One of the primary steps in management development in any enterprise is proper organization. After the business has been conceived and the broad policies which are to be pursued have been established, and before any operating methods may be devised, at least a skeleton organization must have been developed. Operation and operating methods depend largely on the organization which has been built up. A business which is well organized has gained an excellent start toward effective operation. Organization is the foundation of most operating management steps. Proper organization simplifies management in ways which are impossible in a business that is not well organized. Much of the criticism which has been leveled at certain methods of management in particular enterprises should rather be leveled at the faulty organization, which made impossible the laying of the groundwork on which these methods should have been based. In a profitable business in which the organization is good, if forward-looking steps in management are tried, they will usually succeed with little difficulty.

Ordinarily the poorly constructed organization is typified by executives at the top who are struggling continually with a mass of detail, who point to their terrific tasks, and perhaps feel that they are not able to take a vacation once in five years. The organization which is well constructed is typified by the smooth flow of detail throughout the executive organization and by chief executives whose minds are free to think constructively.

Definition of terms. The term, organization, has been used in a number of different ways by different authors and often in at least two senses by the same author.[1] In its broadest sense it refers to the relationship between the various factors present in a given endeavor. Thus land, labor, capital, and the entrepreneur may be combined in various relationships to produce an economic organization. Factory organization concerns itself primarily with the internal relationships within the factory such as responsibilities of personnel, arrangement and grouping of machines, material control, and other technological matters. Viewed in

[1] See E H Anderson and G. T. Schwenning, *The Science of Production Organization*, John Wiley & Sons, Inc., New York, 1938, pp. 9-15 for a detailed discussion of the various usages of this term.

this light, *organization is the structural relationship existing between the various factors in an enterprise.* It is the structure within which the various factors operate to achieve the objectives of the institution. Organization is sometimes used to refer to the personnel, functioning within a given structural set-up, or to the functioning unit as a whole. These two uses seldom cause any great confusion.

System is a mechanism of management functioning within an organization. *System* is subsidiary to organization and *arises when procedures have been standardized.* System is the crystallization of procedures whereby the efforts of men and departments are co-ordinated and integrated. System is *regulatory in nature* and not within itself constructive, although it may be a means of simplifying constructive effort. System is not an end in itself and must be carefully used not to develop into a stifling influence.

Basic considerations in organization. Prior to discussing specific fundamentals of good organization or particular types of organization development, it will be well to think of some broad organization considerations. By organization is meant the structure of the enterprise, especially from the standpoint of the development of the duties and functions of the parts thereof. The purpose of building up an organization is to provide for a daily routine and effective operation of a business or department with a minimum of direction from above. Organization carries out its purpose by determining the scope and limits of each individual or group of individuals in a business undertaking, together with their relationships and contacts with each other. By a consideration of fundamentals and types of organization, an executive builds up a structure for his business or department which is peculiarly suited to its needs.

Organizations must be developed primarily with regard to peculiar conditions within the business. The application of the fundamentals of organization will differ widely in two different businesses. The size of a business, particularly, has an effect on the way in which the organization develops. On the whole, with the small business it is possible to develop essentially the same type of organization as may be developed in the large business, except that the duties of several people in the large business will necessarily have to be combined in the small one.

The type of business will be found to affect greatly the development of the organization. Thus it will be found that steel plants, textile mills, paper mills, or refining plants, although they have the same fundamentals to deal with, will necessarily apply them in different ways. In a manufacturing business, if the product be standard, ordinarily the organization will need to be differently constructed than if the product were diversified. The same amount of business may be handled with fewer

chief executives if the product be standard, because it is easier to delegate authority in such businesses. Even the location of a plant or the departments within a plant may affect the exact way in which the organization is constructed. The effect of location on the personnel may demand this

To build up an effective industrial organization requires proper observance and application of a series of "fundamentals of organization." These fall into two main groups, primary fundamentals and operating fundamentals. The primary fundamentals must be considered by the executive when building up the scheme of organization and prior to giving any considerable attention to the operating fundamentals. The operating fundamentals may be said to be executive in character. They put into effect the concepts of whoever worked out the primary fundamentals. They aid in the application of these primary fundamentals to the business. The primary fundamentals of business organization may be thought of as dealing with those phases of management which include policy and organization building. The operating fundamentals may be thought of as dealing almost entirely with the operating phase of management.

The fundamentals of organization. The primary fundamentals are fourfold:

(1) Regard for the aim of the enterprise.
(2) The establishment of definite lines of supervision.
(3) The placing of fixed responsibility.
(4) Regard for the personal equation.

The operating fundamentals, which will not be discussed in detail at this time, are four in number also. They are:

(1) The development of an adequate system.
(2) The establishment of adequate records.
(3) The laying down of proper operating rules and regulations.
(4) The exercise of effective leadership.

The operating fundamentals of organization lay down the groundwork for the third of the major divisions of management—operating the enterprise.[2] The first of the primary fundamentals, regard for the aims of the enterprise, serves to tie the developed organization closely to the determination of major policies, which is the first of the three major divisions of management. Thus, through the construction of an effective organization, major policies are followed in operations.

Regard for the aim of the enterprise. Regard for the aim of the enterprise is the first of the primary fundamentals. It is most important at the time when the first steps are taken in the building or development of the structure which is to be termed the organization of that enterprise.

[2] See Chapter I, p. 6.

In no two businesses are the purposes of the management or the conditions of operation entirely alike. It will be easiest to consider this fundamental of organization by considering businesses of diverse natures, wherein it can be seen that the organization structure must necessarily be different in order to meet the several conditions involved. Let us consider the organization which is necessary to take care of the unusual occurrence wherein speed of attainment and not cost is the dominating factor. Such an instance is clearing of a railroad right-of-way after a wreck. All thought of cost is thrown aside and an organization is constructed which, by main force, will have but one end in view, namely, clearing the tracks and letting through the trains at the earliest possible moment. Compare this to the organization necessary for the operation of a huge manufacturing plant which is to remain in existence for many years, whose activities are not only numerous but varied and must all be carried on with due relation to each other. It will be seen readily that the organization structure required in the case of the railroad wreck will be far more simple, far more direct, than the structure which is required to carry on the work of the great manufacturing establishment.

Length of life of the organization and desired speed of results are important factors in the development of its structure. Thus, the organization necessary to construct a number of reviewing stands for a large parade, which will be put up quickly and taken down promptly, may be far simpler than the intricate organization of a construction enterprise which involves the putting up of a huge office building or hotel. As the purpose for which or the condition under which the enterprise operates changes the organization must change likewise. In determining the aim of an organization, major plant policies must be carefully thought through.

The establishment of definite lines of supervision. The second of the primary fundamentals of organization, namely, the establishment of definite lines of supervision, lays down the lines of control which are exercised over the personnel of the enterprise. These lines of supervision may be looked upon as lines of authority, as paths along which orders flow. They are also the paths along which information necessary to the execution of particular tasks is communicated. It must be kept in mind that this path of communication is a two-way path; not only must instructions flow down but reports must come back along the same lines. Care must be exercised not to check the free flow in both directions.

In laying down the lines of supervision, the organizing executive has two main problems at hand. First, he must determine the type of organization to be used. The particular types of organization structure are described in Chapter VII. Second, he must carefully develop and mold the outlines of the type as they can be best applied to his particular

business enterprise In developing his definite lines of supervision he will have to give careful attention to the fourth primary fundamental—regard for the personal equation.

A lack of definite lines of authority will result either in an overlapping of duties or in gaps which are not taken care of by the organization as constructed. The gaps or overlaps may be thought of as *horizontal* on an organization chart as between the lines of authority which have been laid down, as contrasted to *vertical gaps* or overlaps which will occur if the third of the primary fundamentals, namely, the placing of fixed responsibility, is not adequately handled. Lack of definite lines of authority will result in dissension between whole departments of the organization, and thus personal attention of chief executives must be given to the problems that arise.[3]

Definiteness of control through the establishment of lines of supervision implies the idea of *tapering authority*. It implies the development of a group of executives along this line of supervision, each one down the line having somewhat less authority in scope, and somewhat more direction of detail. The job boss, although he has control over a small piece of the business undertaking, is not charged with error in case the undertaking has been wrongly conceived and has proved to be generally unprofitable.

A substitute for each executive within the organization is essential. This substitute must be available to act in case of illness or enforced absence of the superior, and must be capable of taking over his work in case of death or change of duties of his superior. If, however, a plan providing substitutes for executives is being developed, it is essential that all members of the organization have complete confidence in the purpose behind the plan If they gain the feeling that the plan is merely a club to be held over their heads, so that if they do not prove successful at any time they can easily be removed, the plan will fail. Members of an organization can be shown the legitimate purposes of the plan. These are, in the first place, that an executive may be always on duty, and, in the second place, to offer opportunity for advancement, either as executives leave or as the business grows.

In small businesses the desire to have a substitute for each executive sometimes has led to a surplus of executives. It is never profitable to carry this idea to the point where additional executives must be put on the payroll. This consideration is often a real one, as, particularly in small businesses, there is often a wide difference in caliber between the executive head of a department and anyone else in that department.

[3] See C. L. Jamison in Willard Thorp (Editor), *Economic Problems in a Changing World*, Farrar & Rinehart, Inc., New York, 1939, pp 380-381, for a discussion of the *scalar principle*.

The placing of fixed responsibility. The third fundamental of organization is the placing of fixed responsibility. To place fixed responsibility accurately eliminates vertical gaps or overlaps of responsibility along the lines of supervision which have been laid down. The more responsibility that can be definitely given to subordinate executives, the easier it will be to develop substitutes for each executive. The more responsibility for co-operation with other members of the organization is made definitely a portion of the responsibility assigned to the individual member of an organization, the easier it will be to co-ordinate operation of the various phases in the business.

There are three main results which are achieved through accurately placing responsibility; namely,

1. Fixed responsibility acts as an incentive to a subordinate. This is particularly true in large organizations.

2. Fixed responsibility aids in the general speed-up of work. It immediately becomes possible to know to whom communications should be addressed or which executives should be called into conference on any particular topic.

3. The accurate placing of responsibility assists in developing discipline as a means of control.

Regard for the personal equation. By regard for the personal equation is meant consideration of the abilities and limitations of men and women. In developing lines of supervision and in fixing responsibility, it is not possible to consider only the factors of the business which would ordinarily demand that decisions of a certain nature be made. It is necessary to take into account the personnel which is available, or which can be made available. Arranging an organization should be looked upon more as a game like chess and less as a game like checkers. Frequently men have been moved across the board of the industrial game as if they were all of equal value, as if one could readily replace the other, as if one could always fit into an organization niche when another had gone, merely because he was a man of approximately the same salary or had previously performed approximately the same duties. Men are of different values and work together in different ways. More frequently it is necessary to consider the man who is available and then draw the outlines of the job to fit his capabilities.

Merely assigning duties to men does not lead to the accomplishment of tasks, and therefore, it is not always possible to draw organization charts and find men to fit them. Some enterprises with branch establishments have organized each branch in exactly the same way, having organization charts for each branch which are exactly the same. It is an outstanding fact that in some of the branches of such organizations it will be found that everything is working smoothly, that everyone

co-operates with everyone else, while in other branches jealousies have arisen, dodging responsibilities is prevalent, and the organization seems to be generally ineffective. The main consideration is that the organization has been outlined, the lines of supervision have been drawn, the responsibilities have been fixed, and the personal equation, the abilities and limitations of the men and women, has not been taken into account.

It will not be possible to enumerate all the factors which must be considered in giving proper regard to the personal equation as a factor in organization. There are several such factors to which attention can be directed deservedly. In the first place, proper consideration must be given at times to thoughts of home and outside worries. It is well enough to say that men or women should leave their social affairs outside of business buildings, but unfortunately, human nature frequently does not permit this. Secondly, the habit and inertia of the personnel of an organization must be considered. New organizations are easier to construct than are old organizations to reconstruct, for just this reason. The "efficiency man," who developed so much trouble for himself, frequently did so because he refused to consider habit or inertia of personnel as a reason to warp lines of supervision to meet conditions as he found them.

Operating fundamentals of organization. The operating fundamentals of organization have been previously noted. They are the development of an adequate system, the establishment of adequate records, the laying down of proper operating rules and regulations, and the exercise of effective leadership. These fundamentals, following chronologically the primary fundamentals in their application, put life-blood into the framework made possible by the primary fundamentals.

The development of an adequate system. Considerable confusion frequently develops in the minds of many who speak of organization matters, in that they speak of some of these operating fundamentals, which are so easily observed, as if they themselves wholly comprised organization. This is particularly true of system. The operating fundamentals are concrete in nature, as compared with the more abstract primary fundamentals, and, being easily seen by the casual observer, are easily misunderstood for organization itself.

System is a part of organization, not the whole. As an operating fundamental it helps to bind the whole mechanism of organization together. System is the existence of order and method in all parts of an undertaking. It relieves the man at the head of the details of execution, and is a bulwark that prevents the lines of authority which have been laid down from being overstepped. It brings work to executives with the preliminary steps completed and ready for their attention, thus enabling them to apply their entire time to matters of maximum responsibility. When all factors in a business are moving in a regular and

accustomed routine, the waste of time and effort involved in repeating the preliminary steps of the solution of any problem is avoided. It is the function of system to provide for this routine, to provide in advance for all detail work, preliminary or consequent.

Although system implies order in work, it does not necessarily imply economy. A procedure may be highly systematic, but still very wasteful. This has caused many highly developed systems rightfully to fall into disrepute, but should not cause any attempt to eliminate properly worked out systems.

The "exception principle"—a development of system. System supplies the motive power for what has been termed the "exception principle" of management. When operating under this principle, instead of the head of an enterprise, of a department, or even of only a few men, attempting to act personally on each case coming under his general jurisdiction, he acts on the exceptional matters only. Frequently recurring matters are made routine, a system of checks and balances having been developed in accordance with responsibilities already fixed, so that these matters may be handled entirely without reference to the executive himself. The exception principle demands that the manager receive reports of all portions of the enterprise under his control. These reports are summarized as far as possible, and even these summaries are carefully gone over by the manager's assistant, if he has one, prior to presentation to the manager for his attention. The assistant can make notations of additional information which he may possess on given points.[4] If he sees that some matter in which the executive is particularly interested has not been properly handled, he may return the report to the compiler for further treatment in that regard.

By the operation of the exception principle, all routine matters may be handled by the executive in a few minutes, and thus he is enabled to devote his entire time to the more important matters which should, by right, demand his personal attention. He may give more detailed consideration to the peculiar cases, which do not fall under the routine. In devoting his attention to these cases, he is enabled to work over them to such an extent that he frequently can correlate them and develop the points of similarity and difference in them, until they, too, are classified and no longer may be termed exceptional, but are routine. He is also more free to consider the broader line of policy of the section of the business under his control. It will be found generally that the operation

[4] The executive must exercise care not to have this editing process function in such a manner as to keep from him vital information about employee unrest and such items. Sometimes his assistants think that he should not be bothered with such details, which, however, are often more important than other items reaching his attention.

of the exception principle, through system, gives fuller opportunity for the development of the other fundamentals of organization, such as fixed responsibility. The executive is able to learn more of the possibilities and capabilities of the various members of his staff, and is thus enabled better to distribute responsibility among them.

Systematic management. There is a condition of management generally known as systematic management, which represents a considerable advance over rule-of-thumb method, and yet which is far from modern scientific management. Systematic management represents a rather full development of system within an organization, without a corresponding development of the more thoughtful processes associated with modern management. In plants where this type of management can be found it will usually be discovered that the executives are methodical in the extreme, and in some departments the smoothness of operation will be extremely high. In systematic management it will usually be discovered that, though considerable attention may have been given to all the fundamentals of organization, the greatest stress has been given to the execution of orders through the development of a complex but generally effective system. It is in this type of management that the importance of the office clerk and bookkeeper reaches its zenith, as compared to the development of the manager, or thinking guide of the enterprise.

Reports as an aid in developing system. A report in part discharges the responsibility of a subordinate to his chief. It is the completion of a task, the end of an assignment of work to be done. Just as an order should communicate all information necessary for execution, so a report should communicate all information essential to appraisal of performance.

The prime requisite of a report is that it shall serve some really useful purpose. Some men require the submission of reports which are of slight, if any, practical value. If reports are to be an aid to the operation of the exception principle, this situation must be avoided. Otherwise a condition will soon arise in which the reports will not be read and will not serve as the basis for action.

The submission of reports is one of the most important functions of the young man who is just entering the field of management, and who secures a minor executive position. The ability of such a man properly to present the subject at hand for the consideration of his chief is one of the most unfailing ways to secure the approbation of the latter. The reason for this is easy to ascertain. The ability to prepare a concise report, which is directly to the point at issue, covers all the necessary facts, and at the same time does not waste space in the inclusion of non-essential details, is the best possible evidence that the subexecutive has an understanding of his work, has completely thought through and analyzed the situations that have confronted him, and that, in short,

he has successfully mastered his job and is the type of person to whom more responsibilities may be given.

Reports to executives should be always concise, should give the general facts and general conclusions, if any, in the first few paragraphs, and then should follow these with such elaboration and data as are necessary in the particular case at hand. In a more comprehensive report such as an economic survey, it is advisable to include a summary and conclusion as the first chapter of the report. This is somewhat more condensed than the summary at the end of the report, but it should include the important conclusions. All information that is susceptible of comparative treatment should be so handled, so that the executive may see trends without having to look up prior reports or other older information. This may be accomplished by the use of graphs or comparable statistical data.

Reports corollary to the development of system may be written or may be entirely statistical. The development of statistical reports involves the same problems and may be worked out along the same lines as those of written reports. Statistical reports, to be effective in the development of system, must readily call the attention of the executive to the unusual figures, and not draw his attention unduly to figures that may be considered normal. Organization reports may be periodic or special. Special reports are prepared on some unusual subject by special assignment. Periodic reports are regularly presented at stated intervals.

The establishment of adequate records. Records, although differing from system, frequently inject into the latter the life-blood which allows it to survive. System without records does not usually prove successful. Records are even more tangible than system. They are definite, and therefore their provision, maintenance, and improvement are more simple than in the case of system. Records give the facts concerning the operation of the enterprise. Their preparation and use make possible the elimination of guesswork from management. They are an operating fundamental of organization because they are used after the primary fundamentals have been established, and by the organization that has been built up in accordance with the concepts of its primary fundamentals.

The provision of just the right type of records in just sufficient quantity is one of the clearest indications of good organization. Too few records are costly; too many records possibly even more so. Once the necessity of records is realized by those in charge of the enterprise, the immediate danger is the development of "red-tape." "Red-tape" is of three general kinds: first, too many records, including some unnecessary ones and duplicate records made up by different departments; second, too many forms to secure essential information which might be secured on a smaller number by combining several; third, the unnecessary refinement of in-

formation. Ordinary processes of manufacture, distribution, or management may easily be halted to secure accurate figures when approximate information would serve the needs of the executive.

As previously stated, there should be as few separate forms as possible. A multiplicity of forms results in their frequent loss, and consequent absence of information that is needed because one of many forms relating to a particular problem is not at hand. Forms should be of standard size wherever possible,[5] in order that their handling, as well as their filing, may be expedited. They should be constructed so that they are read easily, with the most important information standing out most clearly when the form is filled in. An integral part of "adequate records" is to maintain them physically so that they may be secured when needed.

One maxim with reference to records, as well as other devices of management, is that they are valuable only to the point where the cost of their collection is less than the savings which their collection will effect. Many interesting data can be collected at large cost. If the executive is of the type who likes to know the detail of operations from every possible angle, it is not difficult for him to secure the information. It is likewise not difficult to increase the overhead cost of the business tremendously.[6]

One type of records which usually justifies their cost of collection, however large, if their value be determined in broad rather than in narrow terms, is cost records. Proper cost analysis gives invaluable data on conditions demanding reorganization, and on the operation of the organization, as in results achieved through certain responsibility previously placed. The larger and more complex the organization, the greater is the importance of securing accurate costs.

It is essential that all records, of whatever nature, be compiled so as to indicate trends. Records, like reports, which do not give comparative information frequently are valueless. Certain it is that records that include comparative information are far more valuable than those that do not.

The laying down of proper operating rules and regulations. The third of the operating fundamentals of organization, rules and regulations, is the tie that binds together all the other fundamentals. It defines the scope of the application of system to the various portions of the lines of authority which have been built up. It provides methods for the utilization of the records, and in innumerable other ways it functions

[5] For example, 3×5, 4×6, 5×8, $8 \times 10\frac{1}{2}$ inches, etc.

[6] The use of machine kept records, especially the tabulating card, may simplify record keeping and greatly reduce the cost of compiling many details that would otherwise be almost impossible to accumulate.

to knit the organization together into a unified whole. The establishment of exact rules, either verbal or written, permits authority actually to be delegated, and system actually to work, because *the superior and the subordinate both have a definite concept of their respective duties and responsibilities.* One of the ideals of good organization, namely, the handling of routine without direction from above, is thus provided for by the executive's handling a matter only once, then laying down a rule for its future handling, thus making it a part of routine. Written rules and regulations may be general in character, touching only the broad outlines of business policy, or they may be more detailed in character, taking the form of a "standing order," which may provide the exact method of performance of nearly every task in the business. In developing rules and regulations, care must be taken to insure that they are changed as conditions change, and that they are not so detailed as entirely to eliminate individual initiative and the good effects thereof from the business.

Rules and regulations include proper instruction of the personnel in all the features of the business. Unless written rules are verbally and intelligently interpreted at the time of their promulgation, and the spirit behind them is clearly defined, it is likely that too often they will be observed to the letter, when that interpreter of all business regulations—judgment—should be used.

The exercise of effective leadership. The last of the fundamentals of organization is in many ways the most important, and is certainly the most intangible and the most difficult to develop. The exercise of effective leadership provides the lubrication which makes possible the functioning of the organization as a whole. The more perfectly the organization is developed, in other words, the more intricate the machinery, the more necessary is intelligent executive direction or leadership. Lubrication must be provided when and where needed.

The executive in an organization has two main tasks to perform, organizing and supervising. His organization task, although equally important, is not the one that takes the majority of his working hours. The task of supervision or leadership consumes a majority of his time and consists, in the main, of making decisions and handling the exceptional cases, as they arise, in a way that will promote the smooth operation of the organization. In carrying on this work, if the executive be capable, he will at the same time provide inspirational leadership for his subordinates.

Frequently in developing the responsibilities in his division of the business, an executive can find someone in his organization who has qualities of leadership that can be exercised in a subordinate position. Successful enterprises usually have such men in their organizations. If

such a man be properly placed in the organization, the other executives and subordinates will work harder, more whole-heartedly, and in a more sustained manner for the purpose at hand.

There is in organization work a type of individual somewhat different from the ideal leader, who may be termed the "strong man," who is frequently very valuable to an organization, at least temporarily. The strong man is a man at or near the top who brushes aside the carefully developed lines of supervision or responsibilities which have been fixed and, through his own dynamic guidance, operates the organization, or a large part of it. Such men are dangerous in long-enduring organizations because, ordinarily, in case they pass on, substitutes for them cannot be found. However, in new businesses when policies are being determined, such an autocratic head is often far superior, for purposes of getting an organization going, to a group of individuals without his driving power, even though they may work along theoretically correct lines of authority and responsibility. The combination of strong driving force from the top and well-developed fundamentals of organization through the ranks is one of the best, if not the best, means of effective leadership that can be developed.

Effective leadership implies the prior development of the primary fundamentals of organization. Without these, executive control involves one-man supervision of most of the details of a business, with all the attendant difficulties.

Poor leadership is easily observed and comes to light in the inability of an executive to be rid of the papers which come to him for decision, in the man who makes snap judgments, in the man who shows his ignorance of the relationships of the various phases of the business to his own, or in the man who treads the path of custom. The purpose of an executive's presence is to bring together two links in the chain of organization, which, for some reason, have come apart, or to cause two gears in the organization which are clashing to run smoothly.

Standard instructions. The general reason for utilizing standard practice instructions is to give orders through the proper organization channels of the business. Standard instructions are used to show the scope or lines of authority within the organization, or to describe methods of procedure. A procedure involves the interrelationship of two or more persons in the business.

To use standard practice instructions to show the scope of authority of each of the members of an organization makes them an interpreter of the organization chart, if there be one.[7] It is impracticable to show on the face of such a chart all the necessary facts. These standard practice instructions are not necessarily fixed; in fact, it is the usual thing to find

[7] See Chapter VII for illustrations of the organization chart.

them under constant revision. Their value is that during the periods of change, existing relationships are maintained until they are superseded in written form by new information. The value of standard practice instructions, showing scope or lines of authority, is increased when functions are transferred from one member or department of the organization to another. If they are of value in stating current conditions, they are of greater value in bringing changed conditions to the attention of all within the organization.[8]

To describe methods of procedure is the second reason for the preparation of standard practice instructions. Examples of such instructions might include instructions as to the handling of complaints, instructions concerning action to be taken on certain paper work, or instructions concerning the method of estimating the demand for a new article or line to be added to those already manufactured by the company. Such standard instructions clearly indicate the way in which successful management operates. When occasion arises for the development of such instructions, the manager in charge of the function involved sees that the standard instructions clearly indicate the way in which successful management operates. Once this is done, the matter does not come again to the executive's attention, except when a change in the instruction becomes necessary.

Figure 4 indicates an effective way in which a procedure may be visualized through the use of a chart form of standard practice instruction.

Advantages of standard instructions. Standard practice instructions are advantageous and vitalize the development of the organization fundamentals within a business because:

1. They are not likely to be misunderstood.
2. They are less likely to be forgotten.
3. They fix responsibility for mistakes.
4. They clarify the ideas of those giving the orders and thus insure careful thought.
5. They make for change in method that should be continuously improving.
6. They expedite the routine to be followed by members of the organization.
7. They constitute a ready-reference file of executive decisions.

Why standard practice instructions sometimes fail. Standard practice instructions have frequently failed in operation. Their failure can usually be ascribed to one of several causes:

1. Too many orders.
2. Not enough care in preparation.

[8] See Appendix B for an illustration of a standard practice instruction.

3. The preparation of the instructions sometimes delegated too far down in the organization.

Too many orders may be the result of one or two difficulties—either orders issued from too many sources, or too large a number of orders from one or more of those sources. Much difficulty has been caused at times with the development of standard instruction procedures because orders within an organization have been issued from two or more persons. This does not imply that the general manager and the head of the division may not both issue orders, but the scope of their orders should be care-

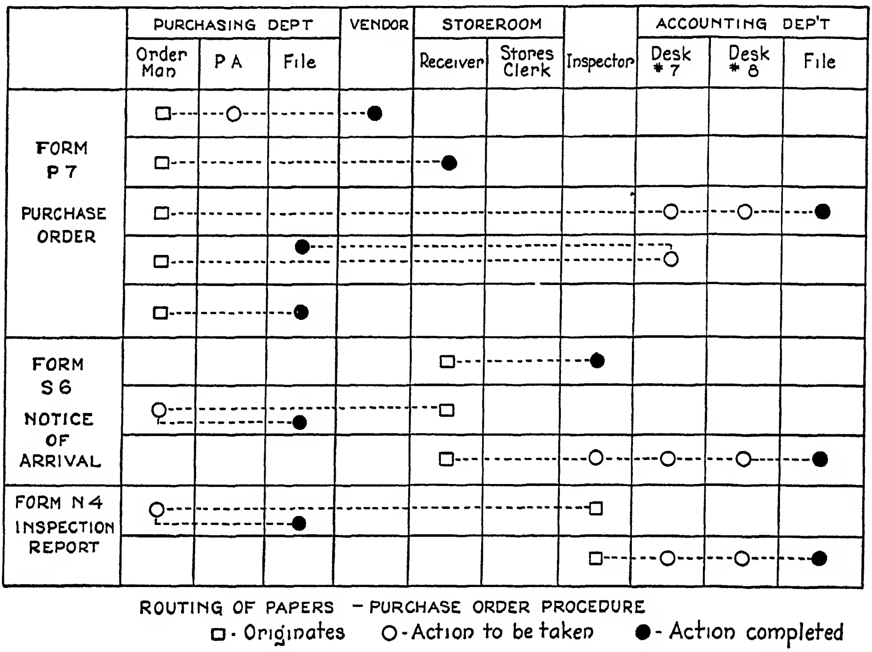


FIG. 4. A Procedure Chart.

fully defined with reference to each other. The difficulty comes when two people begin issuing orders on the same class of details or procedures. There is nothing which will break down the force of standard instructions more than to have two conflicting instructions, both supposed to be binding. The effect of too large a number of orders is almost equally bad. An order which is numbered, for instance, 546, is likely to be regarded lightly. The impossibility of keeping such a mass of instructions in mind is clearly evident to everyone. If it is necessary to revise order No. 36, it is desirable to call it order 36-A merely for the effect on the persons concerned.

The second chief reason for failure that must be guarded against

when preparing standard practice instructions is the failure to use sufficient care in preparation. An instruction should never be issued until it is certain that further consideration would not aid in bettering the working of the provisions made. Lack of care in preparation may include either the use of terminology that is not clear or failure to visualize all the implications involved in the order being transmitted.

The development of the committee idea [9] in management can be of great aid in the formulation of standard instructions. If department heads are thus consulted and the subject discussed from every point of view within the group affected, there will be little complaint, few amendments, and ordinarily the system will prove highly successful. All the advantages of utilizing committees come into particular prominence in this development.

The third reason for failure of standard practice instructions is that some person too far down in the organization scale is delegated to prepare them. This defeats much of the purpose of standard instructions, which is to insure at all times chief executive direction, together with the operation of the exception principle. If a subordinate is delegated to prepare the instructions, the subordinate is actually running the department, if the instructions are observed.

[9] See Chapter VII, p. 85.

CHAPTER VII

ORGANIZATION TYPES

Periods of organizational development. The same fundamentals of organization can be applied in very different ways. These differences in application have brought about the development of rather distinct types of industrial organizations. The development of these types corresponds rather directly with the changes which have come about in American industrial history and which have already been described (Chapter II).

The industrial organization of the first period was usually an organization of the military type,[1] that is, authority flowed directly from the boss to various subexecutives in charge of particular phases of the business, and from them to workers. In the simplest form of this military type of organization, the boss was directly over all the workers in the organization except certain of the factory workers who might be under a foreman. The following diagram illustrates this:

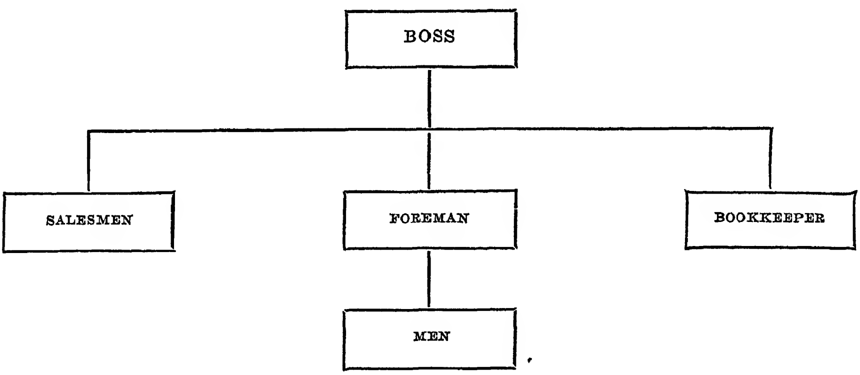


FIG. 5.

The second period of American industry did not bring with it any great change in methods of organization from those of the first period. Such changes as came about merely represented growth in methods

[1] "Military," as used in this chapter, has no connection with methods of organization in the army services today. It refers rather to the straight flow of authority within a single combat unit of an army, sometimes called the scalar type.

utilized during the first period. That is, the military method of organization still continued predominant, and such changes as were made were brought about only by the growth in the size of businesses, and merely represented a delegation of authority over subordinates on the part of the executives near the top in the business enterprise. This is illustrated in Fig. 6.

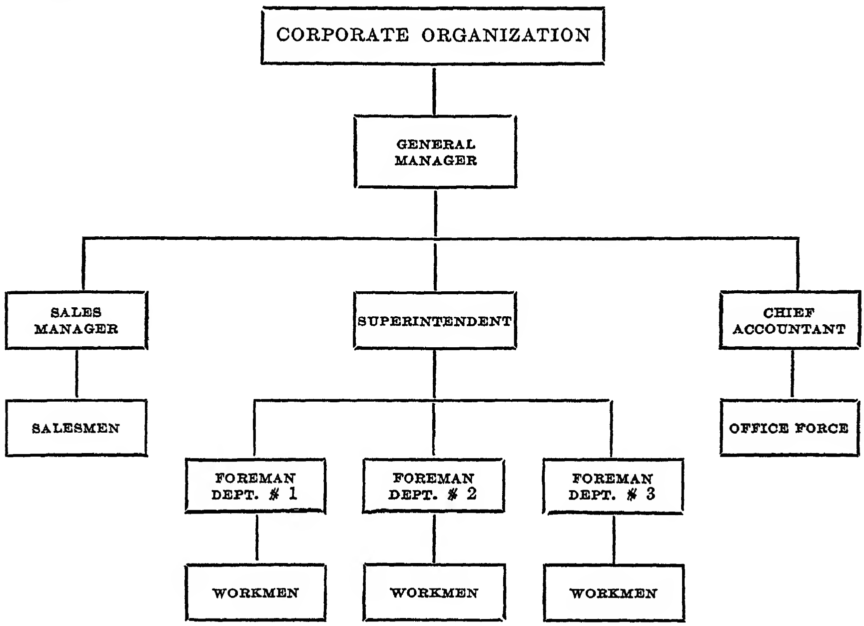


FIG. 6.

The line type of organization definitely fixed responsibility and authority and is effective in matters of discipline. On the other hand, it overloads a few men as the organization grows. Since the duties of these line executives cover all phases of the activities, it is humanly impossible for them to be expert in all of them, with the result that the organization is deprived of expert advice in many important aspects. Should a rare man be strong in all the requirements of the major executive duties and responsibilities, it is reasonably certain that he can seldom be replaced when he retires or leaves the enterprise for any reason. A recognition of these shortcomings in the line organization led to the third period in organization development. This third period in American industry brought with it the development of the functional idea in management and, as an outgrowth of that functional idea, the development of the line and staff or departmental organization of today. The functional concept in organization is a basic contribution of Frederick W. Taylor whose

work will be treated in detail later. Before considering functional organization it would be well to examine the usefulness of the military type of organization.

Usefulness of military organization. Sometimes the advantages of functionalization and the desirability of creating staff departments have blinded executives to an inherent advantage of military organization that no other type possesses. This is the absence of all forms of procedures and red-tape in the military type. Given a strong man who is capable of carrying the load, at times when competition is keenest it may be desirable to fix responsibility for a department entirely on one man, and allow him to develop a strictly military type of organization within his department, so that results may be prompt, and responsibility for them may be fixed exactly. Military organizations can have their heads changed more readily, for there is little co-ordination needed within them, since responsibility rests clearly at the top. It is perfectly possible to develop some departments on a line-and-staff basis, and others, where such conditions exist, on a military basis, in order to secure the advantages of both types of organization.

Taylor's functional organization. In the evolution of the principles of scientific management as practiced by Taylor, he became convinced that the responsibilities of the old line foreman were greater than could be adequately borne by the men available. His solution for this situation was the dividing up of these responsibilities among different men who were especially qualified for their special functions. He replaced the general foreman with four functionalized foremen as follows:

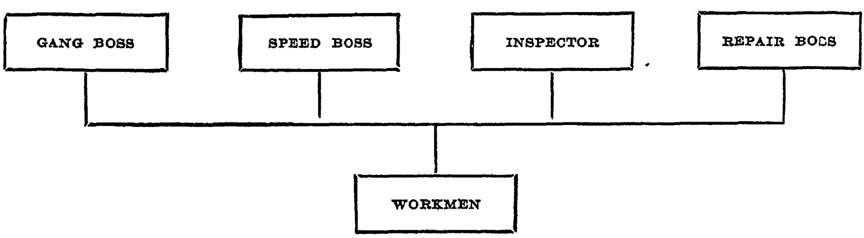


Fig. 7.

In setting forth his plan, Taylor pointed out that "It is because of the difficulty—almost the impossibility—of getting suitable foremen and gang bosses, more than for any other reason, that we so seldom hear of a miscellaneous machine works starting out on a large scale and meeting much, if any, success for the first few years." He further stated that "this difficulty is not fully realized by the managers of old and well-established companies, since their superintendents and assistants have grown up with the business, and have been gradually worked into and

fitted for their especial duties throughout years of training and the process of natural selection. Even in these establishments, however, this difficulty has impressed itself upon the managers so forcibly that most of them have of late years spent thousands of dollars in regrouping their machine tools for the purpose of making their foremanship more effective. The planers have been placed in one group, slotters in another, lathes in another, etc , so as to demand a smaller range of experience and less diversity of knowledge from their respective foremen." [2]

Despite this effort to meet the situation by regrouping of machines, it nevertheless was found practically impossible for a new establishment to secure suitable superintendents and foremen of the business organized along the lines of the military plan. The regrouping of machines, itself, was a mistake in many plants, because the manufacturing process could be better carried on if the machines were laid out as formerly.

Under the military type of organization, the foreman was held responsible for the successful running of the entire shop, and when his duties were measured by the requirements of good management, it became apparent that these requirements were extremely difficult to fulfill under the conditions. The foreman under this system of organization must lay out the work for the whole shop, seeing that each piece of work goes in its proper order to the right machine, that there is a man at the machine to do the job when it gets there, and that he knows just what is to be done and how he is to do it. The foreman must see that the work is done correctly, is not slighted, and is done promptly. Meanwhile he must look well ahead, possibly a month or so, to determine what the demands on his shop will be at that time. He may have to provide more men to do the work, or he may have to try to secure more work for the men to do. The disciplining of the men is entirely up to the foreman, as is all relationship between the firm and the men on the subject of wage, including supervision of timekeeping, fixing or recommending of piece rates or day rates, and the readjustment of these from time to time.

It has been seen that, in order to have good organization, responsibilities must be fixed. That is, each member of an organization must have a clearly defined task, the limits of which are well known. It is evident that there are few limits to the foreman's task under military organization, and that it is unlikely that the task can even be defined. Each day he must decide, on the basis of his own judgment, just what small part of the mass of duties in front of him it is most important for him to attend to. He does a fraction of the work for which he is responsible, leaving the balance of the work to gang bosses and workmen to do as they may see fit.

[2] Frederick W. Taylor, *Shop Management*, Harper and Bros., New York, 1911, p. 93.

Taylor pointed out that the qualities of a well-grounded man were as follows: "Brains, education; special or technical knowledge, manual dexterity or strength; tact; energy; grit; honesty; judgment or common sense; good health." He felt that three of these qualities could be hired at any time for laborer's wages. If four were added together it was necessary to secure a higher-priced man. The man combining five was hard to find, and the one with six, seven, or eight almost impossible to discover. With this in mind, Taylor enumerated, as follows, the duties which a foreman or gang boss in charge of a group of lathes or planers is called upon to perform under the military system and the knowledge or qualities demanded of him on that basis: [3]

> First. He must be a good machinist—and this alone calls for years of special training, and limits the choice to a comparatively small class of men.
>
> Second. He must be able to read drawings readily, and have sufficient imagination to see the work in its finished state clearly before him. This calls for at least a certain amount of brains and education
>
> Third. He must plan ahead and see that the right jigs, clamps, and appliances, as well as proper cutting tools, are on hand, and are used to set the work correctly in the machines and cut the metal at the right speed and feed. This calls for ability to concentrate the mind upon a multitude of small details, and take pains with little, uninteresting things.
>
> Fourth. He must see that each man keeps his machine clean and in good order. This calls for the example of a man who is naturally neat and orderly himself.
>
> Fifth. He must see that each man turns out work of the proper quality. This calls for the conservative judgment and honesty that are the qualities of a good inspector.
>
> Sixth. He must see that the men under him work steadily and fast. To accomplish this he should himself be a hustler, a man of energy ready to pitch in and infuse life into his men by working faster than they do, and this quality is rarely combined with the painstaking care, the neatness and the conservative judgment demanded as the third, fourth, and fifth requirements of a gang boss.
>
> Seventh. He must look ahead over the whole field of work and see that the parts go to the machines in their proper sequence, and that the right job gets to each machine.
>
> Eighth. He must, at least in a general way, supervise the timekeeping and fix the piecework rates. Both the seventh and eighth duties call for a certain amount of clerical work and ability, and this class of work is almost always repugnant to the man suited to active executive work, and difficult for him to do; and the rate-fixing alone requires the whole time and careful study of a man especially suited to its minute detail.
>
> Ninth. He must discipline the men under him, and readjust their wages; and these duties call for judgment, tact, and judicial fairness.

[3] Taylor, *op. cit.*, pp. 96-98.

Functional shop supervision. Taylor felt that the solution to the problem lay in functional shop supervision, as outlined in Fig. 7. He felt that functional foremen, each with but one type of task, would need but four or five of the attributes which he had outlined, and that such men could be found. Under functional foremanship, each workman instead of coming into direct contact with but one supervisor, would receive his orders from a group of specialized supervisors, each of whom performed a particular function. Because of this feature, functional foremanship was never generally adopted, though the development of staff or functional departments to deal with particular phases of the business and to relieve general supervisors of these phases, was a direct outgrowth of the problems of military foremanship, as influenced by Taylor's functional idea. Taylor, in *Shop Management*, set down the proper number of functionalized foremen as eight, four of whom were engaged in general planning work, and thus were entirely removed from the shop. These were really not foremen at all, but staff men working in a production-planning office. "These four representatives of the planning department are, the (1) order of work or route clerk, (2) instruction card clerk, (3) time and cost clerk, and (4) shop disciplinarian."[4]

The four foremen in the shop were to help the men personally in their work, each boss helping only in his particular function. Several of these bosses came into contact with each man only once or twice a day, and then for only a few minutes, while the others were to be with the men constantly, and help each man frequently. There was no specific group of workmen with the same four bosses over them, but rather a number of workmen, falling into varying groups for supervision purposes, but organized into given departments for production purposes.

The following brief description of the work of the Taylor "executive functional bosses" will also serve as a guide to possible division of work between line foremen and staff departments in line-and-staff organizations.

The gang boss has charge of the preparation of all work up to the time that the piece is set in the machine. It is his duty to follow up the plans of the planning men and to furnish all the jigs, templets, sling chains, and other necessary adjuncts for coming operations. The gang boss must show his men how to set their work in their machines in the quickest time, and see that they do it. He is responsible for the work being accurately and quickly set, and should be not only able but willing to show the men how to set the work in proper time. This man has nothing whatsoever to do with the running of the machines, and his work is completed as regards a particular operation when the work is set up in the machine.

[4] Taylor, *op. cit.*, p. 102.

The speed boss must see that the proper cutting tools are used for each piece of work, that the cuts are started in the right part of the piece, and that the best speeds and feeds and depth of cut are used. His work begins only after the piece is set up in the machine, and ends when the actual machining ends. The speed boss must not only advise his men how best to do the work, but he must see that they do it in the quickest time, and that they use the proper speeds of the machine, and so set their tool that they secure the proper depth of cut. He may be called upon, by the exigencies of a situation, to demonstrate that the work can be done in the specified time, by doing it himself in the presence of his men. The words, "speed boss," refer to supervision over proper speed and not to an attempt to "speed up" the workman without regard to his capacities or the time in which the operation should be performed This boss has recently been termed an "instructor" rather than a "speed boss."

The inspector is the third of the shop bosses, and is responsible for the quality of the work. Both the workman and the speed bosses must see that the completed work is up to specifications in order that it may be passed for quality by the inspector. The inspector can, of course, best qualify for his tasks if he is complete master of the machines himself, and can personally do the work both quickly and well. Under such circumstances his rejections will be taken with better grace by both the workmen and the other bosses in the shop. The inspector always sees that the first piece made up is of the proper standard in dimensions, fit, and finish. He also makes further inspection from time to time as the needs of the job may dictate, to see that the standard is maintained.

The repair boss is the fourth and last of the shop foremen. The duties of the repair boss include seeing that the workman maintains his machine and work place in proper working condition. This includes cleaning the machine, keeping it free from rust and scratches, proper oiling, and preserving the proper standards which have been set up for the auxiliary equipment pertaining to the machine, such as belts, countershafts, and clutches. The maintenance of the cleanliness of the floor around the machine is also under the supervision of the repair boss.[5]

Can a workman serve two masters? There is a very deep-rooted conviction in the minds of many industrial managers that no workman can work under two bosses at the same time, and, on this account, the idea of functional foremanship had slow growth as contrasted with the other modern management devices. Nevertheless, the thought that a workman could not serve two masters prevailed, and today we find, not functional foremen, but rather functionalized staff departments, working through one foreman. Recent years have witnessed sweeping changes

[5] Much of the material in the preceding paragraphs is adapted, by permission, from *Shop Management,* by Frederick W. Taylor (Harper and Bros.).

from the military organizations of the nineteenth century. Most of these changes are built around the line-and-staff type of organization, though it is seldom that successful organizations are built without many modifications from the strict line-and-staff type.

In summarizing Taylor's functional idea the advantages may be listed as follows:

1. Specialized skills are brought to the individual workmen.

2. It is possible to find supervisors in sufficient numbers who possess the required special abilities.

3. The separation of manual from mental work takes advantage of the principle of specialization.

The major disadvantages of functional organization are:

1. It tends to complicate problems of discipline among the lower levels of the organization.

2. The co-ordination of the efforts of the various functional foremen is difficult. (This factor among the major executives is not so great a problem.)

3. It tends to narrow specialization among executives and workers.

Line-and-staff organization. This type of organization joins to the direct "line" flow of authority, provided in the military type, functionalized "staff" departments, which deal with one particular phase of the business. Figure 8 shows a simple development of line and staff in the production and sales departments of a business. Those functions marked "X" are staff.

In the manufacturing division of a business, the functional departments guide, and to some extent control, the foremen. In their development, it is assumed that the foremen are intelligent, in fact, that they are the backbone of the operating organization of any plant. The organization is so constructed that the foreman can retain his one-man control over the personnel under him, and at the same time can have his direct responsibilities reduced to a point within the range of accomplishment. The foreman's primary duty is leadership, and under this plan of organization he may better perform this function. The functionalized staff departments give technical operating information and orders to those in direct charge of the workmen.

In the sales division of a business, the functional departments do not direct the operating or line functions in any way, but perform some specific function, such as advertising, which is of direct assistance to the line members of the organization in better performing their duties. Functional departments have this same position in the financial division also.

The distinction between line and staff members of a complicated organization is not always clear. In any case, in an operating organization, it is more important that the line-and-staff idea be utilized in the

set-up of the organization than it is that each individual's duties be clearly line or clearly staff. It is probable that many individuals will have their duties develop so that they will be in some respects line and in some respects staff. However, a line man is usually one whose work controls more than one particular function of the business, and who has under him workers who are directly productive.[6] A staff man usually controls but one function of the business, and workers who are directly

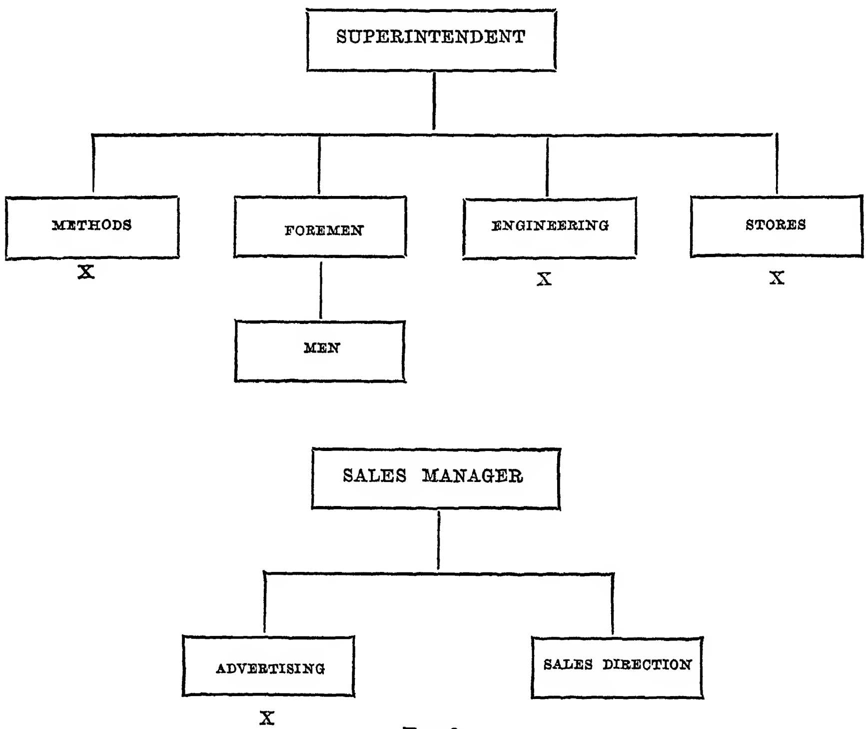


FIG. 8.

productive do not usually report to him. Departments are line or staff, as their heads fit into one or the other of these categories. It may well be observed, however, that a staff department may itself be organized on a line basis.

The line and staff organization has practically all the advantages of both the military and functional organizations with relatively few of their disadvantages.

[6] Productive is here used in its popular sense as referring to work that is directly associated with turning out the product. Strictly speaking all work should be productive or else eliminated.

The advisory free-lance. As business has become more complicated, there have been introduced into organizations persons with duties of a new character. These persons have no administrative authority whatsoever, but are experts in some phase of the operations who report to an executive and advise him on the subject of their specialty. This specialty may be general administration, as in the case of an assistant to the president or an assistant to the general manager; or it may be statistics, finance, budgeting, legal advice, or innumerable other fields. In some cases, as, for instance, in legal advice, the work may be sufficiently heavy to permit the development of a free-lance department instead of an individual. The great advantage of the addition of advisory free-lances to an organization is that they are altogether free of administrative or managerial duties, and hence able to devote all their time to work in the field of their specialty.

The development of the committee idea in organization. Proper regard for the fundamentals of organization will enable the executive to lay out the structure, or framework, of an extremely workable organization of the type he desires. The framework must have built upon it the superstructure of everyday harmony that can be secured only through the whole-hearted support of every portion of the organization that has been outlined. There must be found some lubricant to make the parts of the organization work with each other and dovetail into one another without the least semblance of friction. Only by reaching such an ideal will there be secured an organization that truly functions smoothly.

The greatest fault in creating a new, revising an old, or operating a continuing organization has frequently been the failure of the general executives to give proper regard to securing the co-operation of those foremen and minor executives on whom the success or failure of the organization will ultimately depend. Methods must be suited to the circumstances of the particular business or department. The sympathetic support of all must be secured for the proper operation of the organization, particularly if there are any changes to be made in methods of organization, system, or shop processes.

The co-operation of the men forming the organization is essential. To enlist the co-operation of these men, who in the last analysis are those on whom the success of the operation depends, is, in its larger elements, not a really difficult task. They must have some share in forming the plans, some share in devising the methods of management. They must be made to feel that the methods being utilized are really their own. They must be consulted frequently and thoroughly concerning difficulties, and encouraged to suggest ways of overcoming them. They must be led to recognize ahead of time those rocks on which the ship of management is likely to founder, and to point out the shoal waters where it must run

slowly. It is their knowledge, their experience, and their information about the detail which must be brought to the aid of the developers of management methods.

All plans dealing with organization, reorganization, or operation of a business, which are formulated by the heads of the enterprise, must necessarily be constructed with three cardinal principles of co-operation in mind; namely,

1. Consideration for the viewpoint of those persons who must execute the plan.
2. Persons close to the details of operations may contribute constructive suggestions.
3. Plans will be more effectively executed when the participants thoroughly understand all the causal relationships and factors involved.

The major executive must keep in mind: "What would I think if I were in the other fellow's place? What plans would be most likely to secure my support, develop my latent ability, and bring out the best that is in me for the support of the enterprise?" It is not meant by this that it is necessary in constructing a new organization to keep this idea as the controlling factor in the construction. But this factor must be taken into account and given the weight it deserves.

Plans should be developed along the lines of complete co-ordination. The fact must be recognized that generally the joint advice of a group of men conversant with a subject is immeasurably superior to the thoughts of one man, or any plan developed from one man's brain. The only possible method of developing a proper group spirit is by getting men together. Their jealousies and their distrust of each other can be eliminated only by bringing them into close contact with one another and by steering them in a tactful manner. The spirit of helping each other for the good of the enterprise can best be brought forth by bringing men together in conference. Perhaps the results will be only gradual, but if proper attention is paid to the methods of cultivation they will be certain and not extremely difficult to secure.

From an administrative standpoint, all persons interested in a given phase of management should have knowledge concerning factors in the business which influence the daily conduct of their jobs. The larger the business the more need for definite co-operation on this point.

A method that has proven to be of enormous value in attaining these ideals is the use of committees as aids to management. The committee idea recognizes the human factor, fosters the spirit of co-operation, implants the new ideas of organization and its fundamentals in the minds of all members of the organization, and gives everyone the necessary contact properly to perform his tasks. The committee idea, through organized committees, secures, on troublesome problems, the advice of

those best qualified to aid. It stimulates these men to give the company the best that is in them. The standing committees solve routine problems of operation, but also learn of and advise concerning policy and organization development.

Committees are used extensively in organization today, and they are largely advisory committees. They usually suggest courses of action to the chairman, aiding him in reaching the decisions for which he is held responsible. He may accept or reject these decisions, but normally, if the committee work is properly developed, matters will be thrashed out there, and the decision will be practically final.

Formation and duties of committees. In each organization, the problems affecting the men who form the committees would vary, so as to make hard-and-fast rules for the organization of these committees largely out of the question. In most cases the factory superintendent would be chairman of the most important factory committee. Those men in the other phases of the organization who hold similar relationships to their portions of the organization should head their committees. In large enterprises, where the superintendent would naturally have several assistants, these may be the heads of the less important committees, though it has been found in some cases that the work of the committees frequently renders the assistant himself unnecessary. From four to seven men have been found to form the ideal committee in size. A smaller number of men is likely not to provide for sufficient discussion, while a larger number is likely to prove unwieldy.

As a rule a committee is not well adapted to the collection of facts or technical data. A member of the committee or an expert under the direction of the committee may collect the facts and the committee evaluate the facts or formulate a policy supported by these facts. Such a policy is likely to be more inclusive and to consider the broader implications than a policy that is the work of a single individual.

Organization charts. Organizations have their photographs taken through the preparation of organization charts. These set down on paper the structure of the organization, by indicating positions or departments, and then showing the lines of supervision between them, as well as frequently stating definitely under each position or department the responsiblities attaching thereto. As will be seen, organization charts, like other photographs, are not wholly satisfactory, inasmuch as many little details and interrelationships of live, operating organizations cannot be pictured properly on a chart. But the most satisfactory way of studying modern organization development is through the ultilization of a typical organization chart. In studying such a chart it is well to remember that the titles given individuals or departments in various enterprises vary with the whims of the organizer, even though the duties performed be

essentially similar. The attached chart (Fig. 9), which will be used as a basis of this discussion, will indicate the organization of a relatively large enterprise, because it is in such a concern that the various functions are most clearly separated and defined. It should be clearly understood that in small concerns, although the same functions would exist, many duties would have to be combined. The gigantic corporation such as General Motors (Fig 10) has a more complicated organization in the upper brackets than the organization illustrated in Fig. 9. This is made necessary by the problems of co-ordinating the activities of the various divisions, each one of which is a large enterprise by itself.

It would be claiming too much to say that Fig. 9 is a typical organization chart. It is illustrative of many organizations. In practice there are innumerable exceptions to the exact positions of various departments assigned in Fig. 9. Where product engineering is highly technical or the style element is of special importance, the product engineer often reports to the vice-president and general manager. It is not at all unusual to have a plant engineer reporting to the general superintendent or the director of manufacture. In such cases the power department and the maintenance department would report to the plant engineer. Other exceptions will be pointed out in later discussions.

The typical organization. All organizations have at the top the owner of the business. This may be either an individual, a partnership, or a corporation composed of a group of stockholders. In studying organization, it will be best to consider the most complex of these, and the one most typical of our present economic life, namely, a business owned by stockholders. In such a business the distinction between the corporate or ownership activities and the operating activities is ordinarily clear cut. The stockholders usually select, through their elected board of directors, a president who is actively engaged in the direction of the corporate policy of the business. The president supervises all the truly corporate activities of the business, but ordinarily does not supervise the operating activities except in a relatively small organization. In carrying on his work, the president is assisted by duly selected officers, having control of certain parts of the corporate work, such as the treasurer, in charge of company funds and financial policy, and the secretary, in charge of corporate records and stock transfer. The functions of the treasurer and secretary should not be confused with somewhat similar ones incident to the daily operation of the business. In the type of organization being described, these latter functions would be controlled by executives under the control of the general manager, who has charge of and is responsible, through the president, to the board of directors for the operation of the business. In many smaller concerns, there is no president, but a general manager who reports directly to the board of

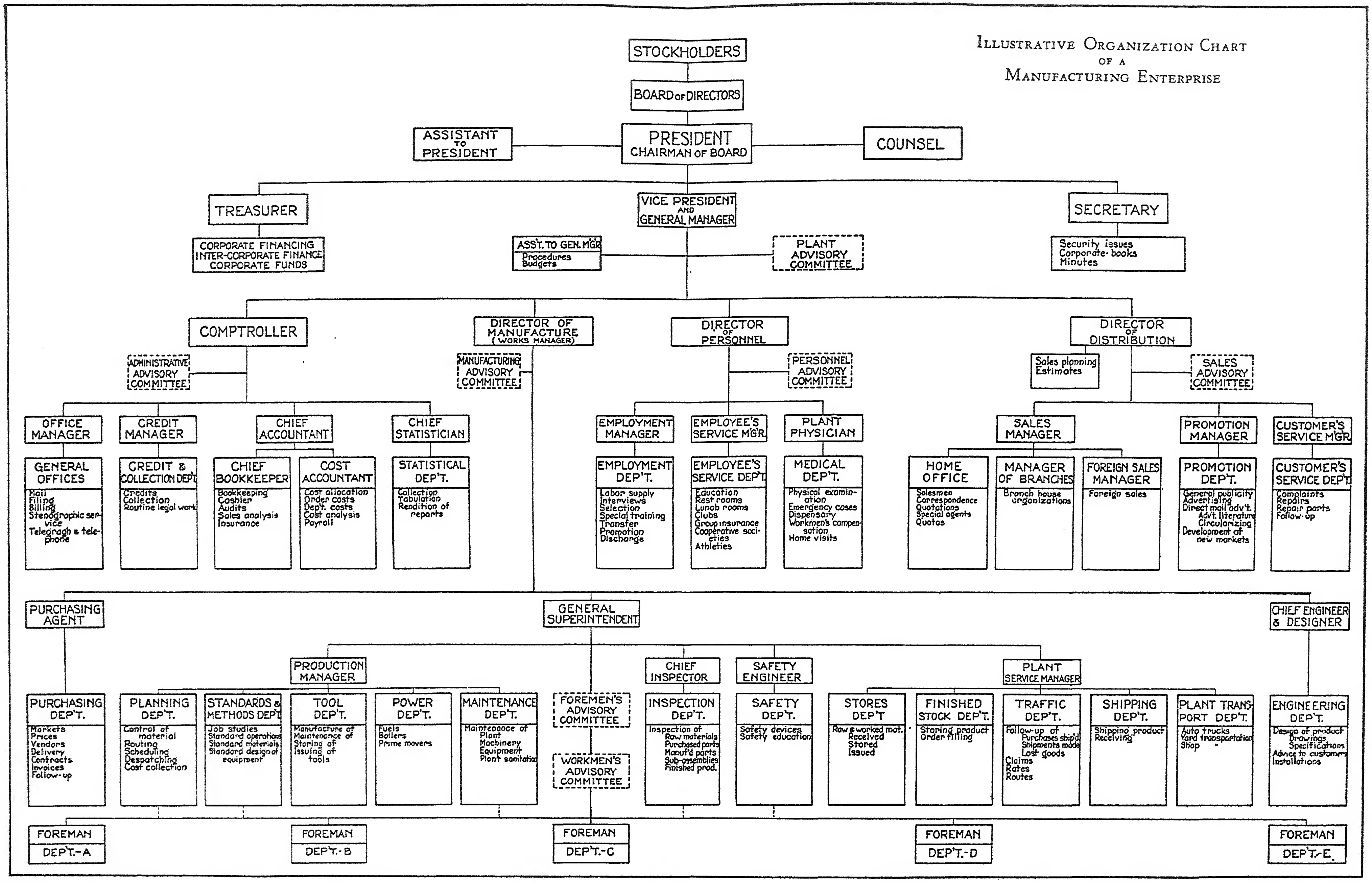


FIG. 9.

To face page 88

directors, or the president and general manager may be the same person. In such cases the treasurer is in charge of operating work as well as corporate work. Thus routine accounting and record work would be under the control of the treasurer. It is usual to have the secretary of the company keep only the corporate records, regardless of the organization.

Principal divisions of the enterprise. Under the general manager, or operating head, of the enterprise, there is an immediate split into divisions of operation, functional in form. There is, for instance, the *comptroller* who deals with all office, accounting, and record operations; the *manager* or *director of manufacture* who has under his control all matters relating to plant operation and the manufacture of products; the *director* or *manager of distribution* who controls sales; and, in many modern organizations, the *director of industrial relations* who deals with all matters concerning personnel. In this development of the main operating organization it will be noted that there are but few main divisions, which means that there are but few persons reporting directly to the general manager. This is an essential of good organization. It gives the general manager an opportunity for real policy development, which he does not have if he has a large number of persons reporting directly to him.

A necessity which is often overlooked is that of sometimes creating special temporary divisions for carrying on some special or unusual work. Examples of this would be found in the creation of a "new building" division, in case a new structure were being erected for the business; this division would have supervision over construction and movement into the new building, or the creation of a "Government work" division when Government contracts are held by the business.

The manufacturing advisory committee. A tentative personnel for the manufacturing advisory committee would include the designer of product; the head of the *sales department*, or the member of the production organization whose function is to effect liaison with the sales organization; the head of the *cost department;* the *general superintendent*; the *purchasing agent* where purchasing is a major item; as well as the *director of manufacture* who would preside over the committee's deliberations. Other men may be added to the committee when considering special items. The production manager should sit in on the discussion of production schedules. The director of personnel often is a member of this committee. The plant engineer usually is a member of this committee when plant changes are being considered. The representative of the sales department need not sit in on some of the meetings of this committee where items are being considered that do not directly affect sales. Other members of this committee need not attend its meetings when special items in which they are not interested are the major

factors for consideration. A copy of the minutes, however, should go to every member of the committee. The secretary should not only preserve information concerning actions taken but should straighten out many difficulties between meetings, and have matters for the committee's attention in such shape that it will be possible to get them out of the way in minimum time at the meetings.

The work of the committee can usually well include:

1. Plans to change the product, including a consideration of new methods of design, or new items to be marketed. The interplay of sales and production factors must be considered here.

2. Progress that has been made on changes already begun. This is important, for unless it is considered it will be found that new ideas which have been decided upon and already partially put into effect can be totally forgotten in the press of daily routine.

3. Consideration of methods of cost reduction. Reports by committee members upon economies, decided upon in previous meetings, and assigned to them to put into effect, might be included. In this connection, when work of a specific department is taken up, it is possible and advisable to have the foreman in charge of that department in the committee meeting, whether or not he is regularly a member of the committee.

4. A discussion of routine operation, the status of orders, causes of hold-ups, progress of manufacturing programs, etc.

The number of meetings of this main committee or any other committee are, of course, always to be determined by the needs of the business. However, there probably should be a minimum of one a week, since policy control of each phase of the business should certainly be discussed at least as frequently as that.

The comptroller's division. The comptroller (or treasurer under the second type of organization)[7] has under him certain staff heads, each controlling the operation of one phase of the office work. These men are the office manager, in charge of the general office operation; the credit manager, in charge of the granting of credits and the collection of accounts receivable; the chief accountant; and the chief statistician. A separate section has been set up under the chief accountant to handle costs. (This is a particularly important phase of manufacturing accounting. The collection of cost information is often regarded as a production function and may be placed in the hands of the planning department, under the production manager.) There must of necessity be some tie-up between the distribution division and the credit man under the comptroller. Such a tie-up can well be secured through the committee which advises the comptroller, by placing on the committee a representative of the sales department.

[7] See page 89.

The sales division. The work of the director of distribution falls under several heads, which in large organizations are each in charge of a competent executive. Thus, there are the functions of promotion, including advertising and the development of new markets, sales, and service after sales. The organization of the office of the director of distribution will be found to vary considerably with the selling problems involved in different types of enterprises. Where advertising is the major factor in selling, such as in the case of tooth paste, the advertising division may not be under sales promotion, but may report as a special section to the director of distribution.

The personnel division. The work of the director of personnel has been increased largely both in amount and in responsibility within recent years. Since there will be considerable attention devoted to this phase of industrial organization later, the work of this division will only be briefly outlined at this time. Its functions are clearly indicated upon the chart. In its full development it has jurisdiction over all matters pertaining to the personnel of the organization, be that personnel in the comptroller's office, in the sales department, or in the manufacturing division. See Fig. 104 for an illustration of the organization of the personnel department of a large electric manufacturing organization.

The manufacturing division. Directly under the director of manufacture, or "works manager," as he is frequently known, there is a line man (Fig. 9), the superintendent, who, with the aid of advisory committees, directly controls the operations of the foremen of the various departments of factory. The foremen are directly over the workmen, possibly through job bosses, or assistant foremen, who may be in control of certain portions of their department. There is thus direct line control or authority from the director of manufacture to the workman. It is the establishment of this authority which promotes discipline, and allows for the quick and accurate working of the organization.[8]

The staff portion of the manufacturing organization is to be found partially under the direct supervision of the director of manufacture and partially under the direct supervision of the superintendent. The manufacturing division affords the best opportunity to observe the effect of the functional idea in the development of the staff portion of the "line-and-staff" organization. There is, first, the purchasing agent, in charge of the purchasing department. Under many of the older organization types this function was ordinarily placed on an equal plane with that of the chief of manufacture. In modern organizations, he is sometimes found in the same position. Making purchasing a main division of the business may be due to consideration of the personal equation, but it is

[8] Compare Figure 9 illustrating a complete organization with Figure 11, The Buick Motor Division of General Motors.

generally due to the importance of purchasing in the particular business. Such correlation with other departments as is necessary can be secured through placing him on one or more advisory committees, and still leaving him under the control of the manufacturing manager. The value of placing the purchasing agent under the control of the director of manufacture lies in the possibility thereby secured of correlating his functions with those of the production manager, inspector, and chief engineer, whose duties will next be described. The work of each of these men is bound up closely with the operations of the purchasing agent.

The chief engineer usually has charge of the design of the product, some or all of the equipment used in its manufacture, and related subjects. He is thus particularly qualified to, and it is necessary that he should, sit on several of the important committees, since his work affects nearly all phases of the business. He is usually a member of the Manufacturing Advisory Committee, and frequently he may be found on the Plant Advisory Committee. It is ordinarily a mistake to make the engineering or design department a separate division of the business, reporting directly to the general manager. This tends to lay too much emphasis on changes of design of product, with the result that both sales and production departments are hampered in their operation. However, there are some businesses, such as clothing manufacture and the automobile industry, where the importance of the designer is great, and in such cases the chief design engineer may well head a separate division reporting directly to the general manager.

Under the superintendent in the factory organization are found the members of the staff departments, who deal with particular functions of plant operation. The production manager has charge of those features which deal with aiding smooth flow of production. The chief inspector has charge of measuring the quality of the product or quality maintenance; the safety engineer has charge of the safety work; and the plant service manager has charge of the functions which primarily assist the other departments that deal with production to function smoothly. Under the production manager is the planning department, the standards and methods department, the tool department, the power department, and the maintenance department.[9]

Complete discussion of the functions of these various staff production departments will be reserved for consideration at later times, as each department's operation is fully considered. Nevertheless, a brief statement at this time is desirable. The planning department has complete

[9] The production manager in many organizations does not have charge of the standards and methods department, the tool department, the power department, and the maintenance group. The exact location of these departments depends largely upon their relative importance and personalities.

jurisdiction over all the planning functions handled by the foremen under a strictly military organization, and in addition its development has caused the creation of certain new functions, as enumerated. The standards and methods department is interested in developing and explaining how the work should be done, in order that the planning department may have a basis on which to plan, and the foreman on which to direct. It also provides the inspectors with a basis on which to check the work. The tool department insures that all tools, of whatever character, necessary to production, are ready at the time needed and in proper condition. Thus maintenance of tools is part of the work of the tool department rather than the maintenance department. The power department has charge of the generation and transmission of power throughout the factory. The maintenance department has charge of the maintenance of plant, machinery, and equipment and is the logical outgrowth and development of the "repair boss" under the original scheme of functionalized shop supervision.

The functionalized inspection department, under the chief inspector, is the quality department of the production organization, and although under the superintendent, is distinct from the quantity divisions of the organization as represented by the group under the production manager and the foremen of the various departments. It is especially desirable to have different men working for quantity and quality. At the same time, their work must be correlated under one head. In cases where the product is one with exceptionally high quality requirements, the inspection department may report, not to the superintendent, but directly to the works manager or director of manufacture.

The safety engineer has complete charge of all safety work in the factory. His position is one of great importance. As a matter of fact, in hazardous manufacturing he might become a man of such importance as to be called director of safety and be one of the men immediately under the general manager. There is also the possibility of the location of this function under the control of the director of personnel.

The plant service manager has charge of the stores department, finished stock department, traffic department, shipping department, and plant transportation department. In order to be able to control the planning elements of production, it is essential for the production manager to have close contact with the plant service manager and the operation of the stores department. He must know what material is available for manufacture, so that he may take steps through the purchasing agent to have the necessary material ready at all times. The relations of the production manager's group of departments and particularly the planning department, to the stores department are so close that it logically may be said that stores, and for the same reason, plant transport as well, should

be under the production manager. They are to be found there in many plants. The work of the other departments under the plant service manager is self-explanatory, except that it will be noted that the follow-up of purchases shipped and of finished goods shipped is left with this group rather than with the purchasing and sales departments, respectively. (See Fig. 11, The Buick Motor Company, for another arrangement of these functions.) Follow-up work of this nature may thus be centralized and correlated with the production program. However, this is an excellent example of the type of work in which the personal equation must be taken into account when developing lines of supervision and fixing responsibilities. Given the proper type of purchasing agent or director of distribution, these tasks might easily be split between them.

Departmental committees. Departmental committees, which correlate the work of particular departments of the concern, would operate along essentially the same lines as the main committee. It is probable that their meetings can be held less frequently. It is very advisable to include on these departmental committees some of the subexecutives, particularly in large organizations. This enables these subexecutives to learn definitely about the fundamental policies of the enterprise and, therefore, to be able better to interpret these policies to the rank and file of the concern. This is an important phase of committee system development, inasmuch as misinterpretation of the real policy of the firm is often the underlying cause of many labor disputes. Furthermore, a full understanding of underlying policies of the enterprise makes certain that everyone is pulling together in exactly the same direction.

The development of the committee idea, and particularly the inclusion of the subexecutives in it, undoubtedly has a good effect on the workmen and others in the organization. The subexecutive's position becomes a more attractive one to strive for, since it is now in on the "management" of the company. Furthermore, it is soon found that under the operation of the committee idea, it is unusual for department heads to pick unfit men for subexecutives. This acts as a further incentive to the worker.

Group management. Mr. S. DeWitt Clough, President of Abbott Laboratories of North Chicago, Illinois, in speaking before the Illinois Manufacturers' Association very ably pointed out their experience with group management through the instrumentality of the committee as follows: [10]

> Now in addition to the Board of Directors and the Executive Committee, we have gone further and adopted the committee method of appraising many problems.

[10] Illinois Manufacturers' Cost Association. *Monthly Bulletin*, No. 140, November, 1938, pp. 1-2. See also Charles P. McCormick, *Multiple Management*, Harper and Bros., New York, 1938, for an excellent discussion of this entire subject.

This started some 10 years ago with a General Coordination Committee which functioned successfully until the business outgrew such a single committee. Six years ago the Central Coordination Committee was broken down into smaller committees to handle specialized studies.

First, there is the Research and Control Committee, presided over by our Vice-President in Charge of Research, Dr. E. H. Volwiler. Representatives from the Scientific Staff, Medical Department, and Production Departments sit on this committee. No new products are added without the recommendation of the Research and Control Department, and then only after very thorough investigation, including pharmacologic, pharmaceutical, clinical and medical research.

When a new product has been recommended by the Research and Control Committee, the essential facts are sent to the Products Planning Committee, where there is discussion and decision as to packages, sizes, costs, prices, promotion, literature, samples, production batches, time of announcing the new product and distribution. On this committee sit representatives from the Cost Department, Sales Department, Advertising Department, Scientific Department, Pricing Department and Production Department.

* * * *

Still another committee, styled the K or Kill Committee, keeps our catalog constantly revised with recommendation for deletions of slow-selling items and other related problems. Information on product—sales by months, and years, territorial sales, and inventories is available for study by this Committee.

Other important committees are the Budget Committee, Finance Committee, Suggestion Committee, Study Club Committee, the Safety Committee, the Medical Committee, Personnel Committee, the Legislative Committee, and subcommittees from among our employees, to handle welfare and entertainment projects. We have many employee activities in our organization.

This method of management may appear at first to be cumbersome, but it has its advantages and believe it or not, the system works here. Of course we have had to train, and are still training, these committees and those presiding over such committees, to operate as smoothly and quickly as possible without too much superfluous or time-consuming discussion. The idea of each committee is to try and reach conclusions without permitting discussions to go on detours or up blind alleys. By sticking to a straight line, tactful handling, and reasonable speed, the chairmen of committees can accomplish a great deal without friction or delay. The committees are kept as small as possible.

* * * *

A large number of our young men are trained on these committees for future executive positions. They appreciate the opportunity and the responsibility.

No important decisions are made without the knowledge of several executives.

* * * *

I have found it highly essential to emphasize the importance of constant follow-up of committee recommendations, also the necessity for committee chairmen to assign to individuals certain definite investigations and not to fail to follow up by the review and double check method such special assignments. Without such follow-up, delays and drags will inevitably occur.

* * * *

Foremen's meetings. Another phase of the development of the committee idea which has within recent years proved to be of great importance in factory operation has been the "foremen's meeting," held about once a month. It is necessary to guard against having one man at too many meetings in a week, however, lest his time be taken up entirely with the discussion of what he is to do, and what he has done, and he be not given the opportunity really to do anything. At this foremen's meeting there should be present the foremen and assistant foremen, the members of the Plant Advisory Committee, including the superintendent, and if possible, one of the higher officials of the company.

At these meetings operation problems are the main basis of discussion. Employment and general labor matters have also formed an important subject in recent years. Frequently the labor policy of the enterprise can be so shaped at the foremen's meetings as to eliminate danger of labor troubles.

If the departments in a concern are not too numerous, each foreman should make a statement concerning the status of his own department, and a statement as to whether any other department is causing him or his department any difficulty of any character.[11] As the foremen know that they cannot deceive the other foremen before them, each of whom will naturally defend the work of his own department, such a system leads to the discovery of many causes of retarded production. The ensuing discussion leads to definite plans for the overcoming of these difficulties.

The organization described and illustrated by Fig. 9 is intended only to be illustrative. Modifications of it must be made in the case of small concerns as well as the very large concerns with many plants. Also modifications and amplifications should be made in order to adapt it to particular industries and particular plants.

Although organizations, as found today, can best be discussed from a typical organization chart, as in the preceding paragraphs, nevertheless organization charts of many plants are far different in character from the one just described. It will be well, therefore, to consider briefly the organization charts of one or two specific enterprises.

[11] See C. W. Mason and Glen U. Cleeton, American Management Association, *Personnel*, Vol. 15, No. 3, February, 1939, pp. 144-148, for an excellent discussion of the techniques of the conference method of conducting meetings.

Organization chart of the General Motors Corporation. Few organizations indeed have taken the stockholders and the public more into their confidence than the General Motors Corporation. It is their avowed policy to make known in published form the principles and policies governing operation. Figure 10 illustrates their corporate organization and the relationship of the various divisions to the central organization. One of the basic policies of the corporation has been for many years "decentralized responsibility with co-ordinated control." In studying this organization chart the student should keep in mind the fact that each of the "operating divisions" is a mass production unit within itself and larger by far than most large-scale industries. Of necessity the organization of such an enterprise is more complex than that of a smaller business. For instance the Car Truck and Body Group has an executive vice-president of the entire corporation in charge. From the corporate viewpoint the Buick Division has a general manager as its directing head; however, this same man, when his position is viewed from the standpoint of the Buick Motor Division, bears the title of president and general manager (Fig. 11). This is entirely appropriate and sound organization since this division is much larger than many of the independents in the same industry.

Directly under the board of directors are two important committees, the Policy Committee and the Administration Committee.[12] There are ten major policy groups or committees under the two major committees. Each of these "policy groups" has a policy and an administrative function. These committees illustrate the effective use of committees in the management of a large enterprise. It will be observed that the president is directly responsible to the chairman of the Board of Directors and to the Administration Committee of which the president is chairman. The Administration Committee in turn reports to the Board of Directors over which the same chairman of the Board presides. In other words, the president reports directly to the chairman of the Board of Directors individually as well as the Board of Directors as a committee.

The Buick Motor Division organization chart. The Buick Motor Division organization chart (Fig. 11) should be analyzed in connection with the organization of the parent corporation. For instance, in the parent organization under the Operating Staff there is a Purchasing and Salvage Section and the Buick Motor Division also has a Purchasing Agent. The parent organization Purchasing Section purchases certain items that may be purchased more advantageously by the central organization, while the Buick purchasing agent purchases those items which can

[12] It may be observed that administration as used in this chart would correspond to the term "management" as used in this text.

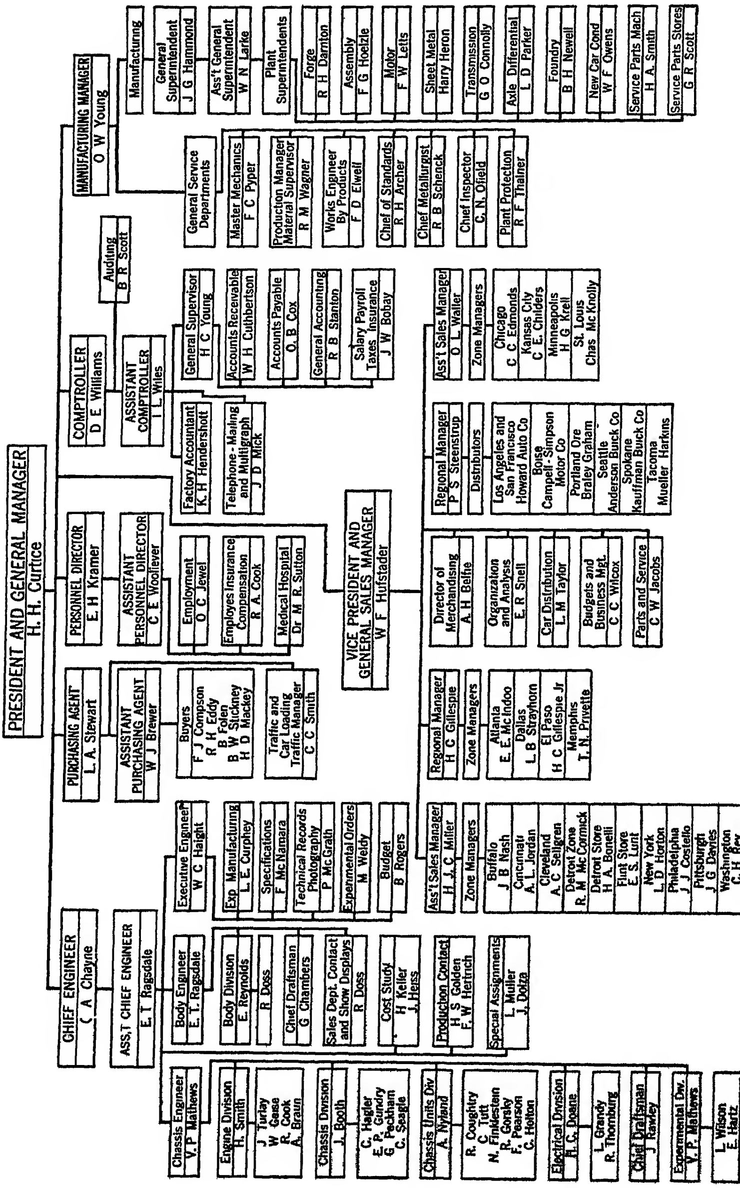


FIG. 11. Organization Chart, Buick Motor Division, General Motors Corporation.

best be purchased direct. The functions of both purchasing groups are large-scale. The chief engineer reports directly to the president and general manager, while the "works engineer by-products," and the master mechanic report to the manufacturing manager. In the strict sense the treasurer's function is not shown on the Buick chart since this function is handled by the Financial Staff of the parent organization. Cost study comes under the chief engineer, while the chief of standards reports to the manufacturing manager. The personnel function is of major importance and the director of personnel reports to the president and general manager.

Oliver Machinery Co. Figure 12 illustrates the organizational structure of a closely held corporation whose major officers are also members of the board of directors of the corporation and its controlling stockholders. Although this enterprise is corporate in structure, it actually functions very much as a partnership might function, each officer discharging the responsibilities for which he is best suited without regard to conventional relationships or individual factory departmentalization. It works because of a high degree of co-operation between the officers of the company. The President, a graduate engineer, is works manager for all three plants, and is in direct charge of Plant No. 1, supervises costs for Plant No. 1 and to some extent for Plant No. 2, and together with other officers supervises designing. The Vice-President, also a graduate engineer, is manager of Plant No. 3, supervises the production schedule and costs for Plant No. 3, and supervises experimental work and designing, particularly for Plant No. 3. The Purchasing Agent, reporting to the Vice-President, buys for Plants No. 1 and No. 3. The Secretary specializes in and has active charge of export sales in addition to his regular duties as secretary.

The Treasurer supervises financing, advertising, bookkeeping records, and purchasing for Plant No. 2. He is office manager for Plant No. 2 and supervises all accounting work for the entire organization. Plant No. 2 is a foundry in which all castings for the firm are made and also engages in jobbing work in heavy machinery castings and die casting for outside firms. This plant is operated as if it were a separate organization. The Treasurer and the Sales Manager are co-office managers for the general office which is located in Plant No. 1.

As stated above, this organization is built around the capacities of the respective major officers, President, Vice-President, Secretary, Treasurer, and Sales Manager. It is conceivable that difficulty might readily be encountered in finding a man to take the place of any one of these officers, with the possible exception of the Sales Manager, should he suddenly be removed from active service by illness or death. As it is now constituted, it has successfully weathered the storms of the depression.

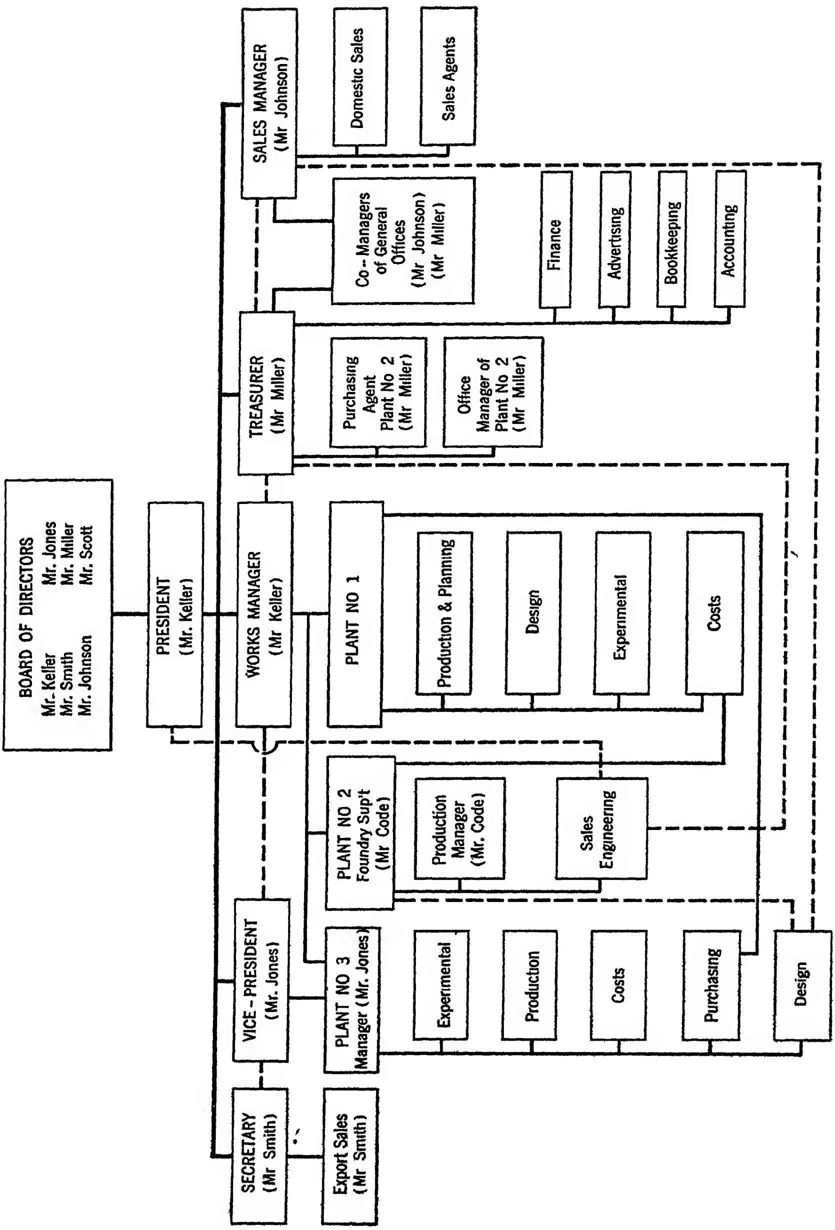


Fig. 12. Oliver Machinery Company Organization Chart.

years and it undoubtedly has the capacity to adjust its organization to the capacities of men available when the present active officers retire. Organization is not an end in itself but a means of achieving the end.

Companies without organization charts. Because they feel that organization charts restrict the scope of activities of executives to too great an extent, some companies refuse to use them. It should be freely admitted that the organization chart is merely a cross-sectional picture of the organization and may have to be changed often unless it merely gives the functional relationships and not the names of the persons discharging these functions. In most cases, however, it is well worth the thought and effort expended upon it. It necessitates management's thinking through the structural relationships and the fixing of responsibility. It also serves as a valuable aid in introducing new men to the organization. The organization chart loses its value unless it is kept up to date.

CHAPTER VIII

MORALE BUILDING AS A FACTOR IN ORGANIZATION

In organization development it is necessary to analyze carefully all steps in order that they may lead in the direction of a morale-building organization rather than toward a morale-destroying one. Carefully developed organizations that are morale-builders succeed. Carefully developed organizations that are morale-destroyers fail.

A morale-building organization tends to utilize fully the skill, initiative, judgment, and training of its members, and through such utilization succeeds in building up these and other qualities in everyone, so that the abilities of all constantly expand, and the organization thus is able to succeed and grow. All members of the organization are encouraged constantly to assume greater responsibilities, at the same time having due regard for the rights of others. Thus all executives become accustomed to think of the duties, responsibilities, and difficulties of their co-workers, with the usual result of co-ordinate action and growth in capacity of the individual. As such businesses grow, and they generally do, opportunities for the fulfillment of the aspirations of their members are afforded.

In morale-destroying organizations, restriction of the individual is the keynote. The organizer generally has hoped to make his careful development of organization fundamentals so perfect that unusual, as well as usual or routine matters will be taken care of promptly and properly in a routine way. The organizer has endeavored to impress his will on the daily actions and relations of all members of the enterprise throughout the business days to come. Into such organizations individuals enter full of enthusiasm, full of a desire to make their tasks and themselves grow, and, through them, the business. It is not long before they become aware of the restrictions that have been imposed, before they learn that the energy they are utilizing in the performance of their tasks is not heeded or is not appreciated. They endeavor to utilize some initiative in their daily operations but they find they are hindered by lack of authority. They try to temper their decisions with judgment but they find it is not accepted or is hampered by supervising judgments. The result of such conditions is uniform. If the subordinate

be worthwhile, if he has sufficient strength of character, and if personal problems do not prohibit, he resigns. If he remains with the business both his character and his ability tend to decrease and to deteriorate until he is no longer worthwhile.

In modern industry, it is not only the executives, but also the privates who must have an organization sense. "Followership" is as essential as leadership. Ability to work together is one of the outstanding requirements for many industrial workers. Therefore organization must be developed to build up, not destroy the ability of its privates to work together. Organizations cannot be built up through the executives only. Loyalty is one of the finest attributes of any member of an organization, but a management must deserve loyalty before it will receive it. Managements that restrict, rather than build up the morale of their working force will get little loyalty from the heart, though they will receive much lip-service.

The line of demarcation between morale-building and morale-destroying organizations cannot be drawn definitely. Conditions which place particular organizations in either category do not develop overnight, and even if it is appreciated that tendencies toward morale-change are present, it is difficult to determine when they should be encouraged, as tending toward good organization, and when they should be eliminated, as tending toward over-organization. For morale-destroying organizations are generally cases of over-organization, although under-organization may also be morale-destroying. The very elements which make for morale-destruction, if applied in proper quantities, make for morale-building.

Conditions that bring morale-destruction. Since there is such close resemblance between well-developed organizations and morale-destroyers particularly in their formative periods, it is necessary that there be considered some means of determining what conditions are likely to bring with them the baneful results. But these conditions, to a certain extent, are essential for good organization development and there are no definite rules which can be used as a guide in keeping away from the dangers of over-organization. There are only certain dangers which must be kept in mind, and all factors must be investigated thoroughly if they appear to be of importance. The most important of these dangers are: too fine division of authority or responsibilities; too many supervisors; improper selection of personnel for new or expanded duties; over-reliance on organization charts; and too few real executives. Any of these conditions is likely to arise in the course of intelligent, well-developed organization work, and their effect must be kept in mind constantly, when considering the fundamentals of organization and other factors which are likely to cause them to appear.

Too fine division of authority or responsibilities. Too fine division of authority or responsibilities is likely to result if careful thought has not been given to differentiation between activities that must be carried on. Although division of authority and responsibility is an essential, this must not be carried to a point that will preclude original thinking on the part of subexecutives. The development of cogs in a machine, rather than thinkers, must be guarded against. This does not mean necessarily that responsibilities may not be divided finely, or that those entrusted with responsibilities may not receive the expert advice of others along particular lines of work, in order that best-known practice may be adhered to. However, it does mean that initiative along the particular line in which he is engaged must be left each executive, in order that he may take pride in the accomplishment of some definite phase of the work, however small. A long train of conditions inimical to successful operation will be started if initiative be denied subexecutives.

Effective leadership is half of an executive's job. It cannot be expected to flourish where individual growth has been prevented. Good executives will not tolerate such restrictions, and will seek other connections. Poor executives constantly become poorer, as they rely always on instructions from above. This last condition forces the management constantly to bring in higher executives from the outside. The final result is that confidence in the business is lost by those on whom its success largely depends, the subexecutives in direct charge of operations.

Too many supervisors. The second danger, which in some phases is very similar to the first, is that of too many supervisors. Such a situation results in conflicts of authority, and failure of the business to progress as might be expected, because of the lack of the push which only can be secured by direct, military supervision. The more carefully organized the concern may be, the more is the chance for this development. The manager or organizer sees a function which is not being performed, and thereupon creates a department or delegates an individual with the responsibility for the performance of this function. If the attention of the organizer be directed to the creation of his technically correct organization, rather than to the cost of supervision or to the driving push so frequently necessary, this condition is particularly apt to arise.

Prior to the advent of scientific management it was common practice to have line executives overloaded with a variety of duties. This led to the development of the functional supervisor with resultant increased efficiency in many instances. Many of the more able executives, who grasped the advantages of specialization of effort and were willing to adjust their organizations to use the new techniques, early pointed out the fact that there is a very definite danger of allowing functions to be

created, merely because they seem to be different, and without an adequate check being provided to see that they are or can be made to be paying investments. There is a very real danger of developing a situation where "for everyone doing productive work there is another man standing over him to see that he does it."

Improper selection of personnel. The third danger lies in the improper selection of personnel for new or expanded duties. Organizations, otherwise letter-perfect, have failed to function because of improper action in this regard What frequently seems the easiest and best method of handling this personnel situation is to create a function and then seek a new person with the qualifications desired, if such a person is not easily found within the organization. Such is usually the procedure when a cut-and-dried organization chart is used, as when several branch houses are organized on the same basis. One difficulty with such practice has already been pointed out under "Regard for the Personal Equation" as a fundamental of organization. It is difficult, under any circumstances, to find the person with the exact qualifications desired, but another difficulty is the effect of this practice on others who have been long with the company. Only under most unusual circumstances should duties be outlined which clearly will necessitate the bringing in of new personnel over old, unless another grouping of duties which would allow the utilization of the old personnel is clearly out of the question. Maintenance of morale demands attention to this point.

Conversely, it is essential that mere seniority within the organization shall not be allowed to govern organization development. Education and the intelligence levels of the persons concerned must be considered. It is true that in large organizations some orderly arrangement of promotion with length of service as a factor must be worked out, or the effect will be the same as bringing in new people for positions near the top of the organization, nevertheless seniority cannot be made the sole or even the most important basis of promotion. If it is seen that length of service clearly outweighs value of service in reassignment of duties or in filling vacancies, the direct effect will be a let-down of effort among those subexecutives on whom the success of the enterprise most depends—those near the bottom of the ladder. The deadening effect of the application of the seniority rule can be found in the listlessness displayed by subexecutives and clerks in the offices of certain large railroad companies, whose promotion or organization development policy is based solely on seniority. Thus it is clear that the manager, in building organizations, must consider his new or expanded duties in the light of two almost opposite reactions of his personnel, the aversion to the newcomer, and the necessity for—and, at the same time, the impossibility

of—following the seniority principle. The effective organization is the one in which the tortuous channel around and between these conditions has been followed with success.

Over-reliance on organization charts. The fourth danger lies in over-reliance on organization charts. Properly used, these may be effective morale-builders, but improperly used, particularly if they become the keynote of operation, they are morale-destroyers. An organization chart is not an organization, but merely a picture of it. The pulsating, co-ordinating activities of organizations can no more be shown in organization charts than can the tang of the mountain air and the stimulating effect of the mountain breeze be shown in a picture of a mountain region. Organization charts serve as guides in organization development, but cannot be looked upon as the result of the development itself. There are a number of reasons for this, which will serve to show the field of usefulness of the chart.

If the organization chart is looked upon as recording all the lines of supervision and all the responsibilities which have been placed, it will soon be found that its influence is too restricting. It tends to make the limitations on the duties of the various individuals too stringent and begets the attitude that anything which does not pertain to the particular department or section is no concern of the persons within that unit of the business. Such an attitude prohibits analysis of the work of others and therefore eliminates that necessary co-ordination which follows a knowledge of the other man's difficulties. Even if responsibilities are stated rather definitely under each main department or section, and attention is called here to the main lines of co-ordination, those most important co-ordinating activities of good executives which they take upon themselves in the daily conduct of their tasks cannot be shown adequately. This calls attention to the second main failure of the charts.

Frequently, since the greatest ability of particular members cannot be depicted adequately, the chart seems out of balance and causes the whole organization to question it. It has been shown that leadership frequently is made effective through some person rather far down in the organization scale. Divisions or departments of the business may be built around the personal qualities and trouble-smoothing abilities of this person. And yet such abilities are not picturable. If the organization chart be looked upon as more than a guide, this man's ability to lead and co-ordinate actually may be throttled. Thus, the free-lance assistant to the general manager who can eliminate much friction as it is about to get started, has duties which it is most difficult to portray satisfactorily on a chart.

These objections and inherent defects of organization charts do not demand that the charts be eliminated, though some executives have come

rather definitely to that conclusion.[1] They do demand, however, that charts be utilized with care, and with these considerations in mind. They demand that in developing organizations, charts be regarded more as a guide to those who are doing the developing, than as a standing order to all within the business, telling each of them their authority and responsibility. Charts frequently may be made more workable, and these objections may be overcome, if supplemented by standard practice instructions, but of themselves, they can never be regulations for organization operation.

Too few real executives. The fifth danger of morale-destroying organization is relying on too few real executives, that is, relying in most phases of the business on the clerical type of individual as a supervisor with a few real executives holding the guiding reins. This condition is often the result of too fine division of responsibilities, but has equal importance and different results. Heads of departments or sections must be real executives. They must be able not only to control and supervise, but also to inspire the men and women under them to better and greater activity. Since no organization can be developed that does not need the lubricating action of executive control, it follows that men of real executive caliber are needed for effective operation. They must be able to sense dangers of morale-destruction within their own departments and therefore must be men who have the ability to lead as well as the ability to carry out orders or carry on functions. Organizers who think consciously of subordinate positions as being chief-clerkships rather than subordinate executive tasks are generally creating a flimsy structure which will not survive in time of business storm. Like other structures, organizations must be built to survive the maximum strain which may be placed upon them. In the ability and action of the executives throughout the organization lies the factor of safety. If provision has not been made for this factor of safety, the structure may collapse under the strain of unusual pressure.

Morale-building organizations. The same fundamental factors that tend to develop a high degree of morale among the members of an or-

[1] A recent survey of the use of organization charts in the automobile industry made in connection with the revision of this chapter showed that General Motors Corporation, as is well known through published reports, uses the organization chart. Three other of the large corporations, whose names we are not permitted to use, reported their status as follows:

(1) "Unfortunately, we do not have a recent detailed organization chart, chiefly because the growth of our business during the past year or two has brought about many changes in the delegation of responsibilities."

(2) "We do not have such a chart"

(3) "The departments are, of course, split up and very definitely organized, but not through the formal type of chart . . ."

ganization, when used in different proportions and with somewhat different emphasis will destroy the morale in the same or similar organization. Overemphasis on the organization chart will stifle initiative and weaken the dynamic elements in a going concern, while an organization chart used with proper perspective will serve as an excellent device for instructional purposes for new employees and recently promoted executives, as well as aid each executive to picture his place in the organization as a whole.

Some executives are greatly surprised when they take over bodily a form of organization that has worked successfully in a similar organization and fail to get the same results. Such executives usually mistake the form for the substance and are unaware of the fact that successful organizations are usually the result of slow painstaking adjustments and growth, that custom and tradition are powerful factors not to be ignored in dealing with human relationships, and that an organization structure has to be adjusted to the capacities of the available personnel. A particular organization set-up might well be a success if installed gradually, permitting the respective personalities to make needed adjustments without undue emotional strains, whereas the same organization would result in dismal failure if inaugurated too rapidly, particularly if forced from the top. Time for seasoning is as necessary in securing a smooth organization structure as in many other relationships.

Clearly defined responsibilities. One of the primary fundamentals of organization is clearly defining responsibilities. A recognition of responsibility with full knowledge on the part of the recipient of the responsibility that he has concurrent authority is a strong motivating force. It results in a high type of morale when authority and responsibility are properly balanced and generally recognized throughout the organization. The proper division of authority and responsibility must avoid too fine a division as previously described under morale-destroying influences. This principle of fixed responsibility should extend down to the individual worker. The typical workman likes to feel that he has a responsibility in keeping with the work he does.

When an individual worker, subexecutive, or executive undertakes to discharge the clearly defined responsibilities that are his, he usually develops a keen organization sense for the rights and duties of others. This recognition of interdependence within the organization fosters a spirit of co-operation, which characterizes a group possessing a high degree of morale. A lack of definite responsibility and authority to meet this responsibility results in hesitancy and uncertainty, whereas, a full knowledge of fixed responsibility and authority produces mutual confidence between members of an organization and a positive attitude toward the organization's objectives.

While it is highly desirable to have organization procedures a matter of record so long as they do not become inflexible, this becomes less necessary where responsibilities are definitely known. Where the organization is one that has attained sufficient age to have undergone a thorough indoctrination with well-developed company policies, many of the procedures are automatically carried out as a matter of tradition or custom. Fixed responsibilities within an organization tend to develop men who are capable and willing to assume the burdens of these responsibilities. The fact that men are accustomed to stand on their own feet, operating of course within certain well-established practices develops a group of minor executives who are capable of meeting unusual situations and emergencies. This encourages the full utilization of the sound principle, *that decisions should be made at the lowest level within the organization where the facts are available and competence exists to decide.* Fixed responsibilities within an organization make maximum use of this frequently neglected principle.

Adequate supervisory force. A well-supervised organization possesses one of the necessary prerequisites to achieving the major objectives. There is no tonic quite so stimulating to morale as attaining a well-known objective or task. Too many supervisors get in each others way and destroy morale. On the other hand too few supervisors create unnecessary delays which likewise destroy morale. It is a matter of delicate balance between too few and too many supervisors. The type of organization determines to a considerable extent the exact number of supervisors required. The nature of the enterprise is also a determining factor. An organization manufacturing a standard product on a mass production basis will require a relatively smaller number of supervisors than one manufacturing a variety of unstandardized products. An overworked supervisory force is tempted to devote its attention to the apparently more pressing needs, frequently overlooking the little details that mean so much to morale development.

Unadjusted grievances tend to be magnified in a geometric ratio to the time elapsing. While this rule does not hold with mathematical exactness, it is nevertheless in general true. Undoubtedly the most effective way to insure prompt adjustment of grievances with its resultant morale-building effects is to have adequate supervisors well trained in the principles and practices of the company.

Effective functionalization within an organization encourages morale-building. This principle can be carried out only where adequate supervisory personnel is available. Skilled men in a given function carry an assurance to their work that gives the positive attitude so necessary to good morale within a group. Even in those organizations having a strong central planning department, there still remains much analysis and

planning for the individual supervisors for their work. This will be done thoroughly and competently in general only when their daily tasks are not so pressing that they take all of their time. It takes time to plan for the organization as a whole and it also takes time for the individual to plan and analyze his work. This is just as true of functional supervisors as the general supervisors.

Proper selection and promotion of personnel. One of the positive contributions of functionalization in management has been the development of the personnel department. This department is charged primarily with the responsibility of properly selecting the personnel and to a lesser degree with promotions within the organization. Men who are well equipped by natural abilities and acquired skills to perform a given task will usually find satisfaction in the performance of these tasks. A group of men who get personal satisfaction out of their work will usually be a happy group. Another factor that goes a long distance in adjusting men to their work is the proper introduction to the job.

A carefully organized promotion policy does much to encourage organization pride and morale. Most enterprises claim to have a definite program for promoting qualified men from within the organization. Few of them, however, have a definite program and adequate records to make such a program a reality. A thorough-going program requires long range planning of a high type. It pays well in the long run, but it also involves costs in the short run. It is seldom that a man is found within an organization who fits the exact requirements of a position offering promotional possibilities, particularly if this position is a newly created one, unless a definite program has been in operation to prepare men for promotion. The easy method is to go outside to find a man for the opening. Such a procedure tends to discourage the men within the organization who are ambitious to advance. This does not mean of course that men should never be brought in from the outside because there is also the danger of inbreeding. A new viewpoint is frequently stimulating. An occasional new man will also serve as notice to men within the organization that they must qualify if they expect to be promoted.

A well-known Chicago manufacturing company with branches throughout the world became keenly conscious of the depressing effect of its slow promotional opportunities in the summer of 1938. It was faced with further curtailment of activities which meant stepping back some of its minor executive groups if previous practice were followed. This company has a long and successful record of enlightened personnel activities. Many of its major executives had reached the age where they were eligible for retirement. Many of these men were still active and not particularly anxious to retire. Pressure was exerted to cause several

of them to give way to younger men thus opening the way for a series of chain promotions which relieved considerably the pressure all the way along the line with a very salutary morale effect.

At times it becomes advisable in an enterprise that has a relatively slow growth to promote men out of the organization. This does not mean discharge but rather that the management learns of openings in other organizations. Worthy men who have no prospects of promotion within the organization in a reasonable length of time are told of these outside opportunities and aided in making the necessary contacts. Such a movement on the part of management soon becomes generally known within the group and the feeling that merit is being rewarded promotes the company morale.

Dynamic leadership. Men like to be led by a strong leader. Sound policies and organizational procedures inaugurated by a decrepit, colorless leader may be recognized but they are immeasurably less effective than when vitalized by that intangible something known as a strong personality. This item is particularly important in the case of the sub-executives who come in direct contact with the working force as a whole. The purely intellectual leader may succeed at the top if he selects wisely his lieutenants who do his contact work for him. The dynamic leader has confidence in himself and the capacity to inspire confidence in others. He knows what he wants and goes after it. He has a definite program for himself and his organization. He knows his own job and expects his subordinates to know theirs. He willingly delegates responsibility and authority and is exacting in demanding performance. He possesses vision and a constructive imagination. Such a leader is loyal to his associates and commands loyalty in return. All of these characteristics are seldom found in one man. It is rare indeed that many men as described above are found in a given organization. Unfortunately many leaders possessing dynamic characteristics temperamentally dislike details. The organization specialist is constantly faced with the problem of compromise in selecting his personnel. Special selection and training are valuable aids in building an organization manned by strong personalities that are accustomed to giving adequate attention to necessary details. The principle of balance is needed in developing dynamic leaders as well as in all other management relationships.

Summary of an executives' conference on plant morale. A few years ago one of the authors was privileged to conduct a series of conferences with plant executives of a large automobile company in connection with their executive training program. Approximately three hundred men ranging in executive rank from plant managers down to assistant foremen participated in these conferences. Each conference consisted of a group not to exceed thirty men in size. The tabulations given below

illustrate the reactions of practical men to the influence of plant morale.

I. Plant morale is the state of mind of a group based on:
   1. Loyalty.
   2. Co-operation.
   3. The "Will to do."
      a. Interest.
      b. Energy.
      c. Initiative.

II. Items to be avoided if a high type of morale is to be maintained.
   1. Favoritism among individuals—nepotism is particularly bad.
   2. Preference to certain groups because of religions, fraternal, or other affiliations.
   3. Display of anger by supervisors.
   4. Hasty and unwise decisions.
   5. Wage discriminations.
   6. Lack of punctuality.
   7. Untidiness in the shop.
   8. Agitation and the spreading of rumors.
   9. Misfits or unfits frequently result in problem employees.
   10. Carelessness.
   11. Unfulfilled promises.
   12. Jealousy.
   13. Dishonesty.
   14. Manifestation of prejudice.
   15. Hasty or unfair discharges.
   16. Belittling management's policies by a subexecutive.
   17. Paternalism.
   18. Too many bosses.
   19. Too much display of authority.
   20. Poorly maintained equipment.

III. Items to be considered in maintaining a high type of morale.
   1. Square dealing with men.
   2. Set a good example. (Do not ask others to do things you would not want to do yourself.)
   3. Recognize ability in others and give credit where credit is due.
   4. Encourage the discouraged. Show a personal interest in your men and their problems.
   5. Plan the work of your department. If possible maintain a steady flow of work.

6. Keep tools and equipment in good working condition.
7. Encourage suggestions from others.
8. Maintain safe working conditions.
9. Give attention to good housekeeping practices.
10. Have a well understood and definite program for promotion.
11. Encourage loyalty by being loyal to others.
12. Encourage co-operation by creating conditions that are conducive to co-operation.
13. Maintain an equitable wage program.
14. Maintain discipline.
15. Clear and adequate instructions.
16. Keep all promises. (Should conditions change, and they cannot be kept, explain the situation at once.)
17. Avoid overlapping of responsibilities.
18. Strong leadership. Men like to follow a man who knows where he is going.

A perusal of these positive and negative factors may show some duplication in minor details. These executives were not particularly trained in the art of expression for publication. They clearly recognized the importance of morale in successful management and spoke out of their many years of experience concerning items that they had observed to destroy morale. They were equally convinced, even though somewhat idealistic, regarding factors that produce a co-operative organization with a "will to do."

PART III

THE PLANT AS A TOOL OF MANAGEMENT

CHAPTER IX

THE FACTORY BUILDING AND PLANT LAYOUT

Plant Layout

In discussing the general subject of the *factory building and plant layout,* it seems logical to treat plant layout first. An enterprise constructing a new building may well construct an ideal layout for the manufacturing process with due regard for flexibility and reasonable change, and then build the building around this layout. It is true that the nature of the terrain and the available land area may make it impossible to build a factory structure in keeping with this ideal layout. Such interferences are more apparent than real for the simple reason that the essential features of the desired layout nearly always may be secured by going up in the air even though ground space may not make possible the long straight line conveyors sought. It is true that it may be somewhat more expensive to build the plant up in the air, but this fact is not controlling, as far as an efficient layout is concerned, if the same plot of ground is to be used anyway. After all, the plant is primarily constructed for the purpose of housing manufacturing processes and protecting materials and the finished product from the ravages of the elements. Plant layout is vital both in processing and in effective storage of materials.

Factors that influence plant layout. It is essential that the type of industry, type of product, type of operations, and type of worker be considered in determining the final plant layout. The industry may be either a continuous or an assembly type. A *continuous industry* is one in which all the material is received at one point, from which successive operations turn it into a finished product, as yarn-spinning, paper, and pottery manufacture. An *assembly industry* is one in which the finished product can be produced only after various components have been made and then brought together for final operations, such as the manufacture

of shoes, clothing, and automobiles. In factory layout, this difference is significant. Some continuous industries are synthetic, that is, the product is obtained by bringing together various ingredients which are worked up in manufacture, as paper manufacture or yarn-spinning. Other continuous industries are *analytical,* that is, the product is obtained by successive processes that separate the final product from the mass of original material. All refining industries, such as oil and by-product coke, are of this nature.

Assembly industries are also of two types: first, those in which the *components are similar* and go through similar operations, as, for instance, clothing; and second, those in which the *components are dissimilar* and go through unlike processes, for instance, automobiles.

The type of product, that is, whether the product be heavy or light, large or small, liquid or solid, is another fundamental consideration. Although the manufacture of spark plugs and locomotives both involve assembly work, layout problems differ materially. Layout problems in any plant in which the product can be flowed, either by gravity or by pumps, from one operation to another, as in flour or sugar manufacture, differ materially from those in which work in process must be handled by hand, conveyor, or truck in moving from one operation to the next.

Certain types of operations make it imperative that they be considered first in making layout plans. Such are wet operations, as leather-tanning or textile-dyeing; operations involving heavy machinery, as large hydraulic presses; and operations which involve fire risk, as in the manufacture of powder or linoleum.

The type of worker is a fundamental consideration, particularly in the employment of women workers, where many decisions concerning factory layout must be changed because of the requirements of these employees.

There are two other factors that markedly influence plant layout: namely, the type of manufacture—repetitive operations on standardized products, usually involving mass production, or the type of manufacture requiring many unlike operations on non-standard products frequently referred to as *job lot manufacturing.* The industry that manufactures in large quantities a relatively few standardized products may be laid out on the so-called *straight-line* or *product* basis as well as the *functional* or *process* basis, whereas the job lot type of industry is almost of necessity largely on the functional basis. Each of these bases will be discussed in detail later in the chapter.

The small-department idea. Many companies have adopted the small-department idea as the basis of their layout. A limit is set, beyond which a given department is not allowed to grow. When the work of a department grows beyond the limit set, there is created another depart-

ment under the same roof, doing the same work, but under different supervision. The layout in many new buildings provides for such division in the first instance. (See Fig. 16.)

Some managers feel that such a plan makes for more adequate supervision. They feel that one foreman or superintendent cannot carry the details of operation of more than a certain number of machines, a certain number of operators, or a certain number of units of product in mind; that no matter how much he may be allowed to delegate his responsibility, he is responsible for more work (not necessarily more functions) than he can handle. Therefore they have split similar operations into several departments, under the control of different foremen, whose relationship to the remainder of the factory organization is exactly the same as if the work being carried on under their respective supervision were of an entirely different nature. The element of competition between like departments is a valued feature of this plan. Some companies separate all overhead by competing sections, even installing separate electric meters to measure the power used by the several departments.

Ideals of layout. In developing the layout of a particular plant there are certain ideals which form the basis, but which must always be modified to fit the given conditions. These ideals are: proper balance of departments and operations; development of production centers; direct-line layout, or layout by product; layout by process; short moves; adequate internal transportation; adequate provision for the receipt of raw materials and the shipment of the finished product; the development of service centers and auxiliary services; and provision for future expansion.

Proper balance of departments and operations. This provides for the elimination of limiting or bottle-neck operations, while preventing over-equipment of any operation. This is of particular importance in continuous-production plants. It is essential that the capacity of each department or of each machine working on each operation be sufficient properly to take up the production of prior operations and to transmit to following operations sufficient product to keep the equipment there fully utilized. Any other plan involves increased inventories of material in process, overtime work, with its attendant increased costs, and general confusion, including utilization of expensive factory floor space for material tied up while in process.

Unfortunately there is no formula for determining the proper balance in equipment, especially in job-lot manufacturing. Experience and careful analysis of previous performance are the best guides. A change in process or the product may throw an ideal balance out of line. It is an ideal toward which management is ever striving, but which requires constant vigilance to approximate and retain.

Development of production centers. Production centers, rather than work-places, should be provided within the departments. Instead of considering the worker and his machine the unit for which space must be provided, each worker tending a group of machines or each machine tended by a group of workers should be looked upon as a production center. The production center should include the workmen, the machines, space for storage of raw material and completed units from the operation, supplementary apparatus of any kind needed in the performance of the operation, and a share of the aisle space required between that production center and the next.

The importance of the machine as the basis of production in modern industry frequently makes a factory floor a succession of similar production centers.

Direct-line layout, or layout by product. Layout by product implies that operations as a rule are performed in a sequence as needed and that the product is worked upon in its processing or assemblying as needed. A theoretically perfect layout by product would be one in which all parts, sub-assemblies, etc., would be started at just the right time to be ready when needed and would keep moving until the final product would be removed from the end of the assembly line. It is self-evident that no such processing would be practical save in a very simple product. Direct-line or straight-line layout, as it is sometimes called, is almost never found in industry in its pure state; however, it is the most popular type of layout for certain parts of mass production manufacturing. The ideal of straight-line layout can be attained most nearly in quantity-production plants producing standard products, but even then it is complicated by the following factors which are always present in plants producing diversified products:

1. The use of the same machine on more than one operation in the process. It may be inadvisable to erect two machines, particularly if one operation will not keep one machine continuously employed.

2. The performance of two or more operations by the same worker, as in felling operations in the clothing industry. Where each part moves quickly and is easy to handle, it may prove cheaper to move the material than to move the worker.

3. The necessity of placing all operations in the production line with reference to the peculiar considerations already enumerated, such as the type of product or operation. Thus, many operations must have special light, such as cloth-examining in clothing plants, or wool-sorting in woolen yarn plants, where the light should come from the north. Tanning vats in tanneries must be placed on solid ground because of their weight and the wetness of the operation.

Thus, in striving for direct-line layout, continuous compromise of the

ideal is often necessary when facing particular conditions. Direct-line layout is applicable either to a particular floor of the factory or to the building as a whole. (See Figs. 16 and 19.)

The central idea behind layout by product is a continuous flow of materials in process toward the finish product stage. The ideal would be to receive the raw material at one end of the plant, to start it in production, and to receive the finished product at the other end of the factory with practically no lost time in storage along the line.[1] In summary, the advantages of layout by product are as follows:

1. Minimizes "back hauling" and internal transportation.

2. Facilitates production control. When a product is once started along the line it is difficult for it to be sidetracked.

3. Shortens the manufacturing time from the first operation to the finished product.

4. Reduces the work in process inventory.

5. Somewhat reduces the required size of the finished product inventory, since production control is more complete and promises to customers from production are more reliable.

6. Facilitates the use of material handling devices and conserves floor space.

7. Tends to eliminate "bottle necks" when properly adjusted.

A few of the disadvantages of layout by product are:

1. Increased investment in equipment, since a machine may be required to perform a certain operation in a given sequence and the quantity of work to be done will not keep it busy.

2. Decreased flexibility. Changes in the product may require an entire rearrangement of the layout. Job lots are difficult if not impossible to handle.

3. Specialization in supervision is difficult to secure. There may be only one spot welding operation on a line while there is a great deal of electric welding somewhere else in the shop.

4. It is often more difficult to expand production beyond the capacities of the lines in layout by product than in the functional layout; however, within the capacities of the lines in layout by product, there is considerable flexibility by adding or taking off men and adjusting the conveyor speeds accordingly.

Layout by process. Functional layout or layout by process is characterized by the assembling of similar operations in one place; thus all punch presses would be in a punch press department, all drilling would be performed in a drill press department, all electric welding would be

[1] Layout by product does not require straight line processing even though the term is often used. It merely implies continuous processing. Modern conveyors will turn corners and go from one floor to another.

done in the electric welding department, etc. This type of layout is the logical carrying out of the functional idea promulgated by Frederick Taylor. It has much to commend it for certain types of manufacturing such as job lot manufacturing or the manufacture of non-standardized products. The main advantages claimed for layout by process are:

1. Better utilization of the skill of the workers following the principle of specialization.

2. More effective use of specialized abilities of supervisors.

3. More complete utilization of equipment, hence a lower investment in equipment.

4. More flexible in that changes in operations and the sequence of operations seldom involve a change in layout.

5. More easily adjusted to changes in volume of production, especially when it is necessary to add equipment.

6. More readily adaptable to special needs of equipment such as exhausting fumes, protection of workers against flashing of light in electric welding, etc.

In other words the functional layout is strong where product layout is weak and weak where product layout is strong. It should be pointed out that it is seldom that an industrial enterprise of any magnitude is wholly laid out on either a functional or a product basis. Many of them, however, are predominately of one type or the other.

The disadvantages of layout by process are essentially the same as the advantages of the product type of layout; namely,

1. Excess back hauling of materials in process.

2. Production control made more difficult than layout by product.

3. A longer time required from the time work is started until the product is finished than layout by product.

4. Excess work in process inventory.

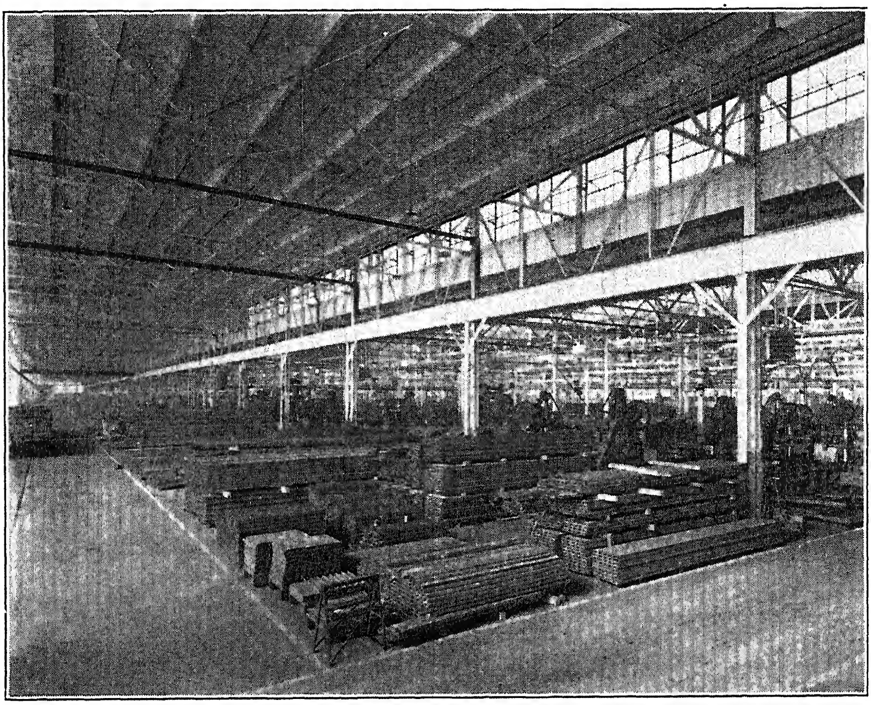
5. Tendency to increase the finished stock inventory if the same service to customers is given as is accomplished under product layout.

6. Automatic material handling is made more difficult and uses more floor space for the same volume of production than layout by product.

Short moves. The layout should be planned so that the transportation of the material from one work center to another involves as short a move as possible. It has been proved the poorest kind of policy, however, to save space in a factory at the expense of men or materials. The mistake of crowding operators has been made, only to find that the subsequent loss of production per worker was far more costly than a comfortable layout would have been. Figure 13 shows the manner in which the Caterpillar Tractor Co. stores materials immediately adjacent to the first operation. Machines are arrayed so that the finished product of

one operation may be passed to the next operation with a minimum of handling.

In standard production, if operations are so arranged that material can be handed or sent in chutes from one worker to another, the ideal of short moves is achieved. The same result is often accomplished when the worker receives his work from a moving conveyor and places it back on the same conveyor from which the worker on the next operation takes



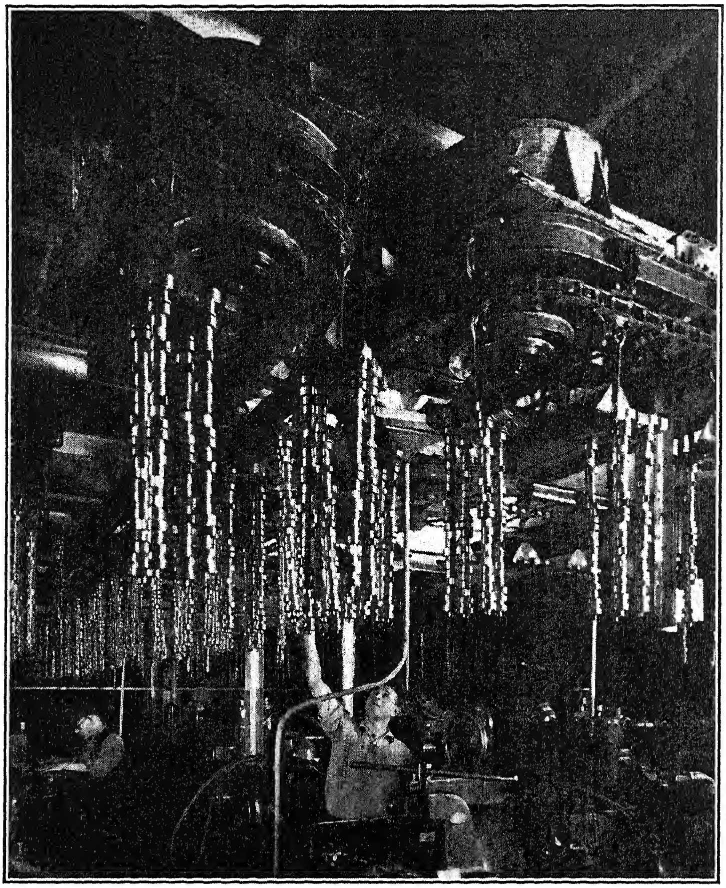
Courtesy Detroit Steel Products Co.

FIG. 13. Interior of Plant of Caterpillar Tractor Co., Peoria, Ill. (Monitor roof over craneway for material handling, saw-tooth roof over manufacturing floor. Heavy material located immediately adjacent to first operation. Short moves and adequate material handling.)

it. (See Fig. 14.) Workers on assembly lines can be placed as close together as material storage conditions permit, but greater flexibility is achieved by having the original line provide for space between workers, which space can be filled in later as operations change or production increases.

Short moves increase in importance as a layout factor if the product be heavy and unwieldy. However, conveying apparatus has greatly decreased the cost of long moves, and has in effect practically put machines or departments at a distance from each other in direct line.

Adequate internal transportation. The first and most important factor connected with adequate internal transportation is adequate aisle space. This must be amply sufficient for all trucking requirements, and

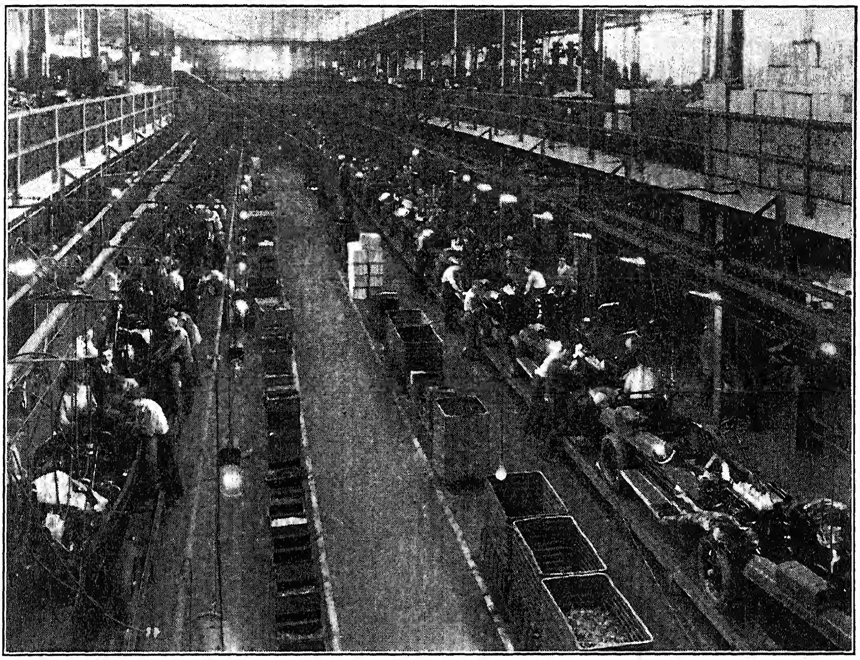


Courtesy "Automotive Industries."

FIG. 14. Moving partly-machined camshafts by overhead conveyor at the Ford Motor Company Rouge Plant. (This company pioneered this method of handling materials between operations. When the worker needs a piece on which to perform his operation he merely reaches up and takes one. When he is through with his operation he places the piece once again on the conveyor line which threads throughout the department.)

must be kept clear, possibly by painting white lines upon the floor. (See Fig. 15.) Main aisles must be considered separately from the space allowed when figuring production centers. Material handling is such an important phase of modern industrial operations that this subject is treated more extensively in a later chapter.

Development of service centers. Service centers include the tool, stores, dressing, rest rooms, and lavatories that form a necessary part of every plant. These centers should be convenient to the actual processes but should not obtrude upon them to the hindrance of production. The shorter the distance from the operations to these centers, the less time will be consumed by workers going to and from the workplaces. It is advisable to place the rest rooms separate from the locker and dressing rooms where possible, particularly where women workers are involved.



Courtesy "Automotive Industries."

FIG. 15. Mezzanines and Final Assembly, Chrysler Plant, Detroit. (Sub-assemblies on the mezzanine are carried by conveyor to the floor below. Note storage of material in trucks and tote boxes adjacent to the proper operation.)

As a rule, the service centers should be in those parts of the premises where the light is least desirable. Frequently, it has been found possible to place the service centers on balconies between floors. This is naturally a big space-saver as well as a convenient arrangement as regards proximity to the processes. Another good arrangement for these centers is to place them in divisions of the process or in natural divisions between buildings or parts of the same building. This tends to bring these centers into close proximity to the entrances, exits, and elevators. (See Fig. 18.)

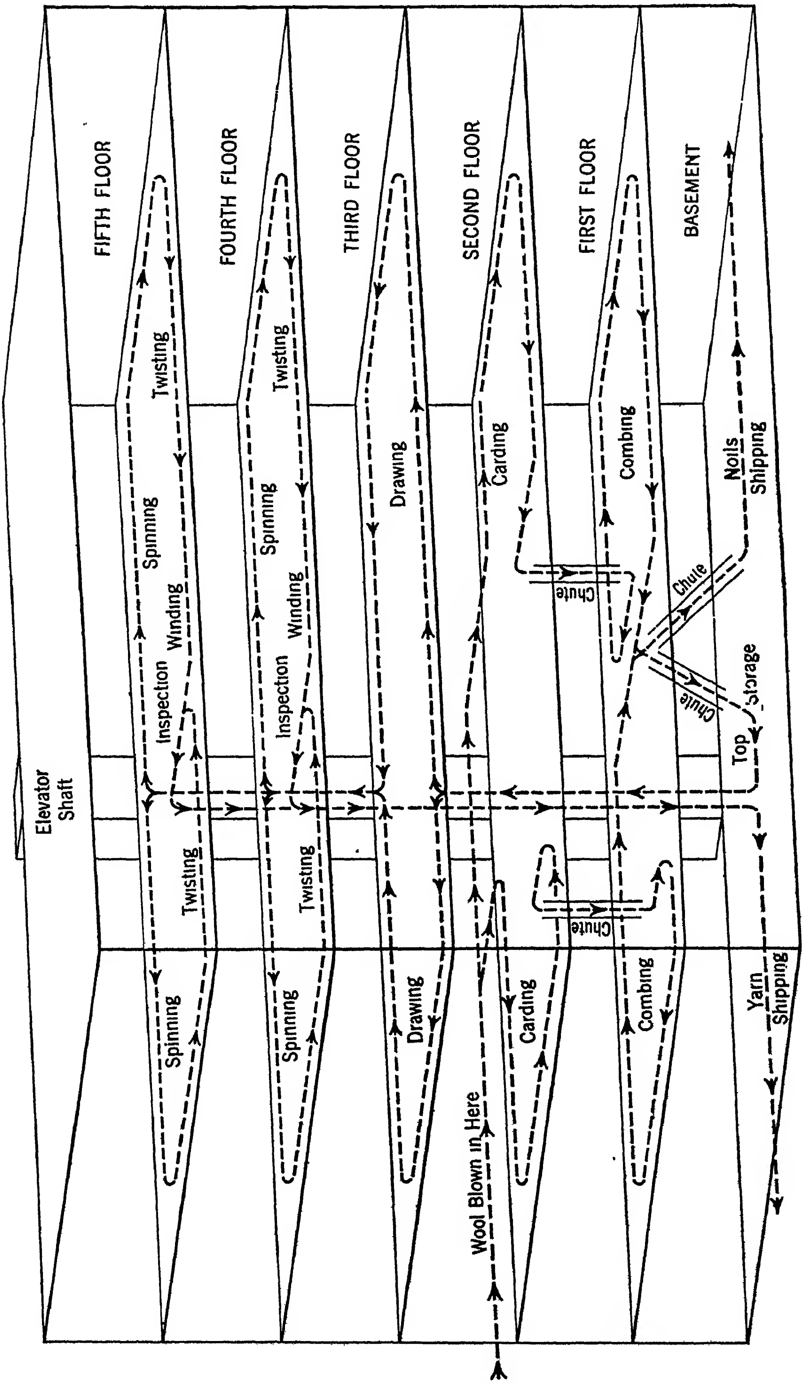
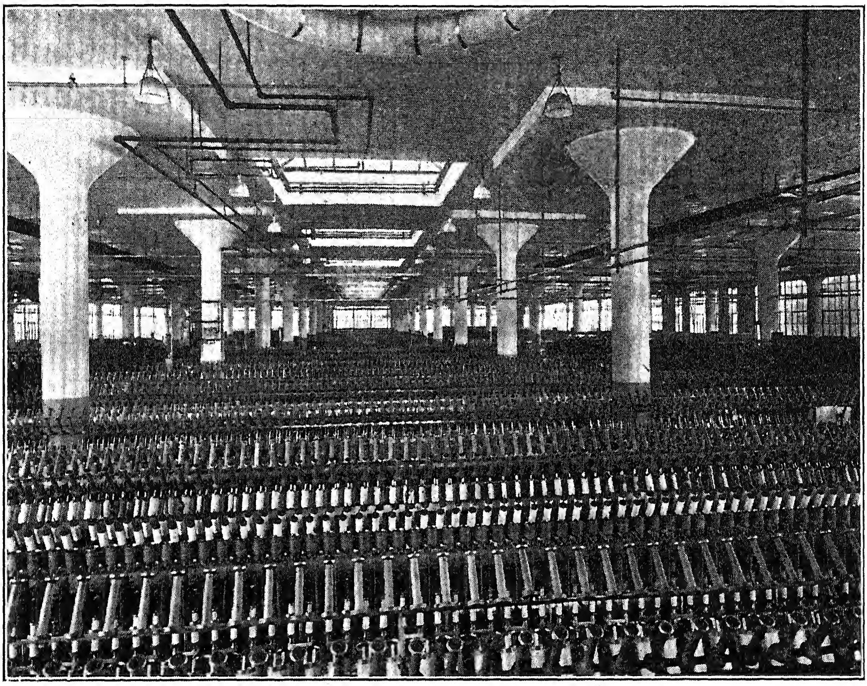


FIG. 16. Vertical Layout, Worsted-yarn Plant, James Lees & Sons Co.

Some Illustrative Plant Layouts

Principles of plant layout may be more readily understood by describing a few typical examples. Accordingly a yarn plant, a washing machine plant and a twine mill will be presented in some detail.

An example of effective layout. The worsted-yarn plant of James Lees & Sons Co., Bridgeport, Pa. (Fig. 16), is an excellent example of the



Courtesy The Ballinger Company.

Fig. 17. Fifth Floor Spinning Units, Worsted-yarn Plant, James Lees & Sons Co.

application of the ideals of layout, made with the necessary consideration of a number of limiting factors. Figure 16 illustrates the vertical floor plan of this plant. It will be noted that the raw material, wool, is blown on to the second floor. This comes from another building, where it has been washed. After the carding operation on the second floor, the material is dropped by gravity to the first floor, where it is combed. After being combed, the noils drop into bags in the basement, from which they are shipped by truck to the purchaser of these short fibers. The combed wool, in the form of tops, is also dropped down by gravity to the basement, into the top storage, where it is aged two weeks before

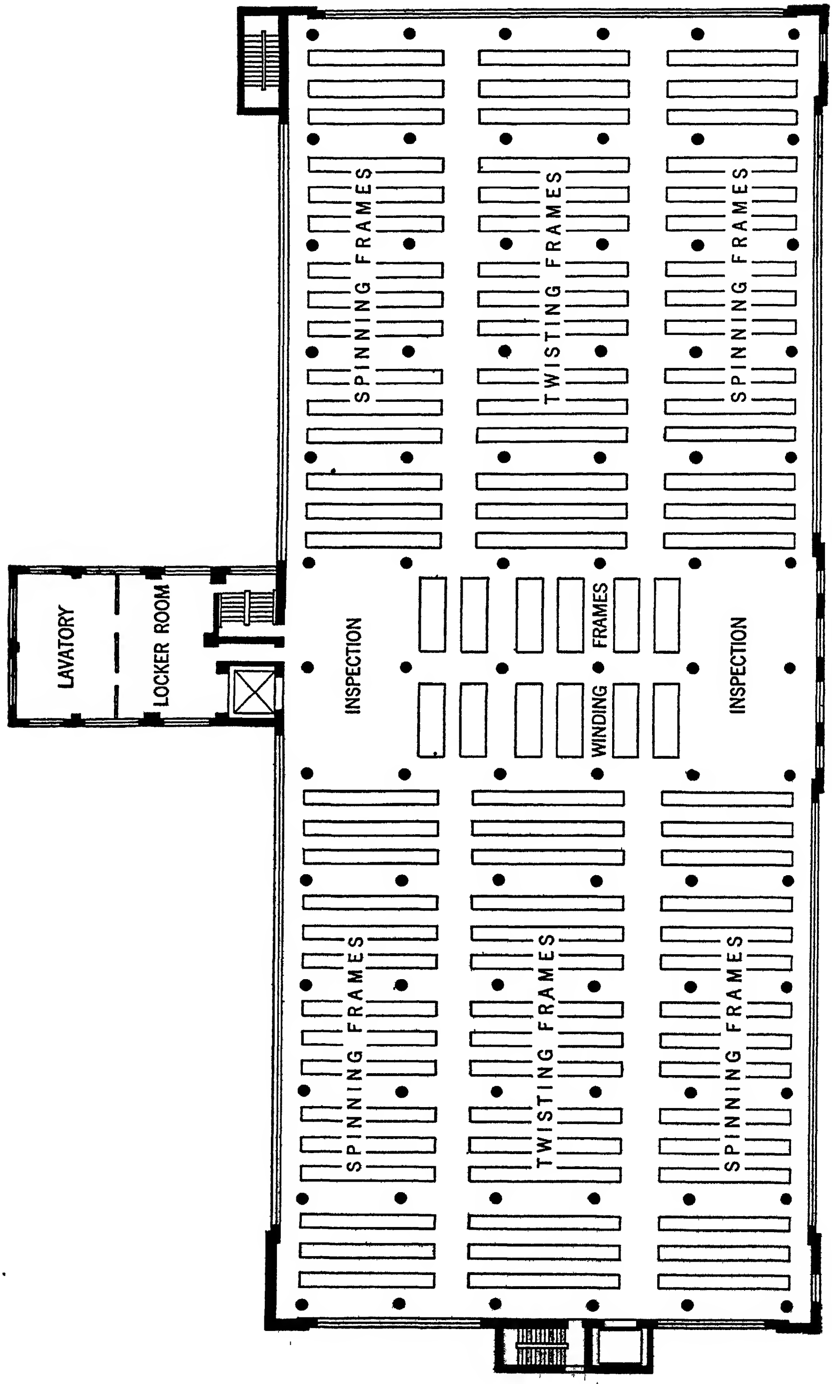
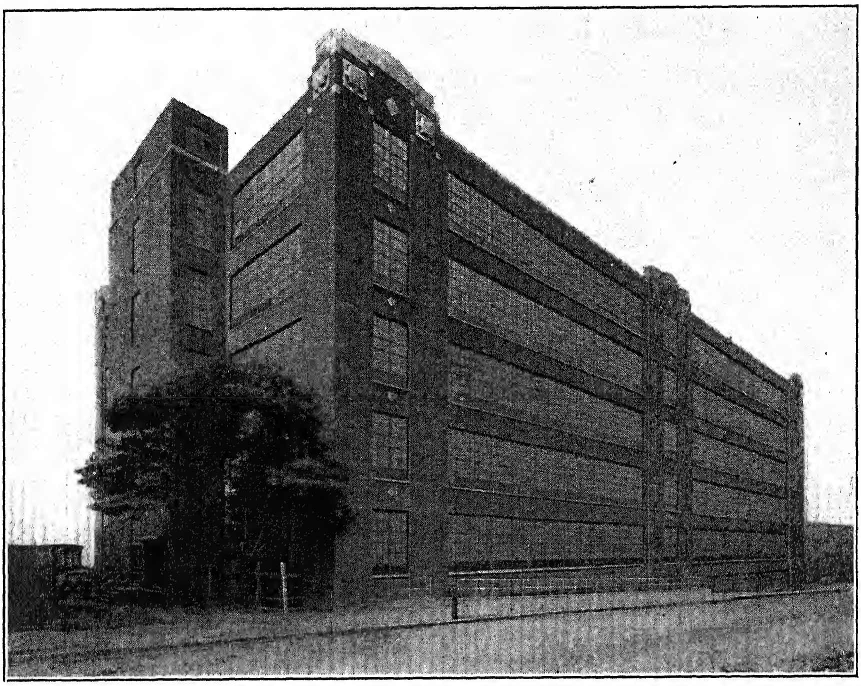


FIG. 18. Layout of Spinning Floors, Worsted-yarn Plant, James Lees & Sons Co.

further operations are performed on it. Although gravity is used in these operations, the material henceforth must be transported by elevator, because it is no longer in such shape that gravity may be used. The spinning, twisting, and reeling operations, which demand the most light, have been placed on two like floors, the fourth and fifth, while drawing is performed on the third, where the material is received from the elevator as it is brought up from the "top storage," which is located in the basement since it requires little light.

The fourth and fifth floors (see Fig. 18) are excellent illustrations of the small-department idea. There are two spinning and twisting units



Courtesy James Lees & Sons Co.

FIG. 19. Worsted-yarn Plant, James Lees & Sons Co., Bridgeport, Pa.

on each end of each of these floors, each under the supervision of a different foreman. One row of twisters takes the product from two rows of spinning frames, on each side of it (see Figs. 17 and 18), while, after the yarn is reeled onto skeins, it is inspected and sent down the elevators to the basement for shipping.

The service centers, dressing rooms, lavatories, elevators, and stairs are located in a wing at the back of the center of the building, while there are firetowers for safetv at each end.

On the third floor, the drawing frames are arranged so that the tops are placed on the frames in the center of the floor, and the finer drawing operations, requiring more light, therefore are performed near the windows on each side of the building.

An interesting feature of the James Lees & Sons Co. building is the absence of all exterior columns, permitting continuous natural light to flood the whole interior, except where broken by stairways or other

Courtesy The Cleveland Crane & Engineering Co.

FIG. 20. A Well-lighted Building, Making Maximum Use of Natural Lighting. This building is equipped with tramrail on the outside to facilitate window washing.

necessary features. Comparison of this building with another modern building, (Fig. 20), illustrates this feature.

Provision for future expansion. In new buildings, provision is usually made for future expansion. In the building just described, expansion would be in the form of another unit, connected with the present building at the wing in the center. Logical enlargements may be made to buildings constructed along the so-called U, L, H, T, or E types illustrated in Fig. 21. In making plans for expansion the effect upon the availability of natural light as a result of the expansion should be considered. Closing

the end of a *U*-shaped multi-stored building may reduce the available natural light on the first floor as much as 30 per cent.

Washing-machine assembly layout.[2] The Easy Washing Machine of Syracuse, New York, has placed the assembly of its washing machines

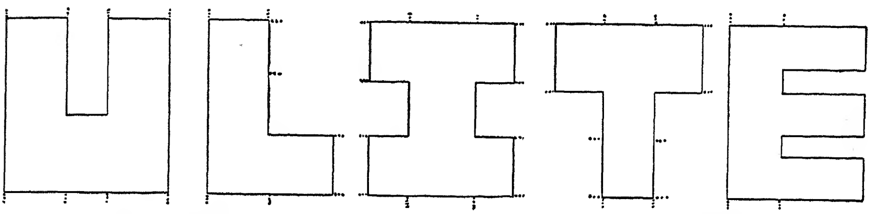
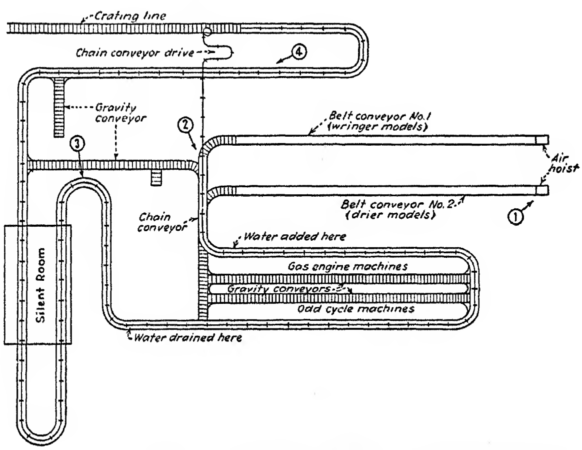


FIG. 21. Ground Plans of Industrial Buildings Indicating Possible Directions of Expansion.

on a series of conveyors. This assembly department is portrayed by the simplified diagram showing the department layout (Fig. 22), and the two pictures illustrating different stages of the assembly, Figs. 23 and 24. Other departments of this plant are also laid out to facilitate material handling and manufacturing operations.



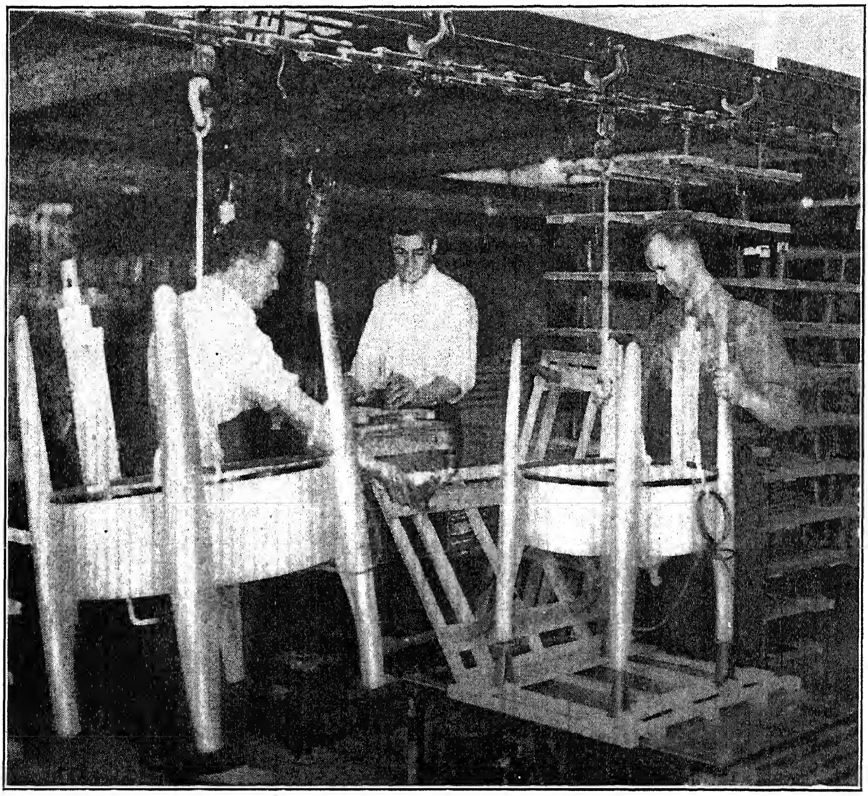
Courtesy "Factory Management and Maintenance."

FIG. 22. Simplified Diagram of the Final Assembly Department, Easy Washing Machine Corporation, Syracuse, N. Y.

Binder twine mill. The McCormick Twine Mill of the International Harvester Company in Chicago has a plant layout which is an excellent example of the straight line or product type. It is essentially a pure

[2] The pictures and diagram are reproduced from *Factory Management and Maintenance*, July, 1939, pp. 65-67, with the permission of the publisher, McGraw-Hill Publishing Co., Inc.

type of layout by product since the entire plant is devoted to the manufacture of one highly standardized product. The raw material is unloaded from the freight cars into the raw material storage from which the material as needed is drawn for production. Figure 25 is a simplified flow chart of the sequence of operations from the time the raw material is received until it is shipped. The plant has five stories in the manu-



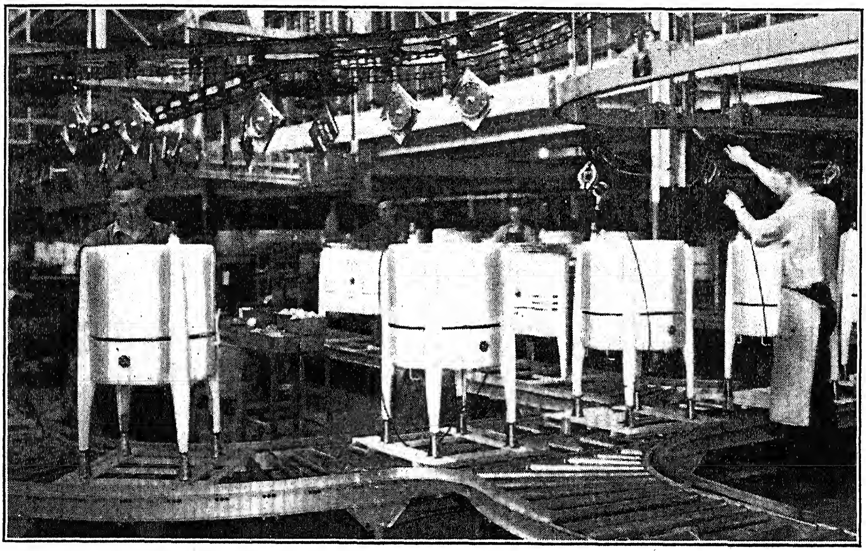
Courtesy "Factory Management and Maintenance."

FIG. 23. Beginning of Final Assembly, Easy Washing Machine Corporation, Syracuse, N. Y.

facturing division. The first, second, fourth, and fifth floors are devoted to preparation and spinning and the third floor is devoted exclusively to spinning. There is excellent balance in equipment and the material moves as effectively as is possible in a five-floor building.

Balance is sometimes difficult to obtain in continuous line production. Figure 26 shows two arrangements for printing wallpaper. The top arrangement portrays the continuous flow of the raw material until it is wound up in small rolls ready to be bundled and shipped to the consumer.

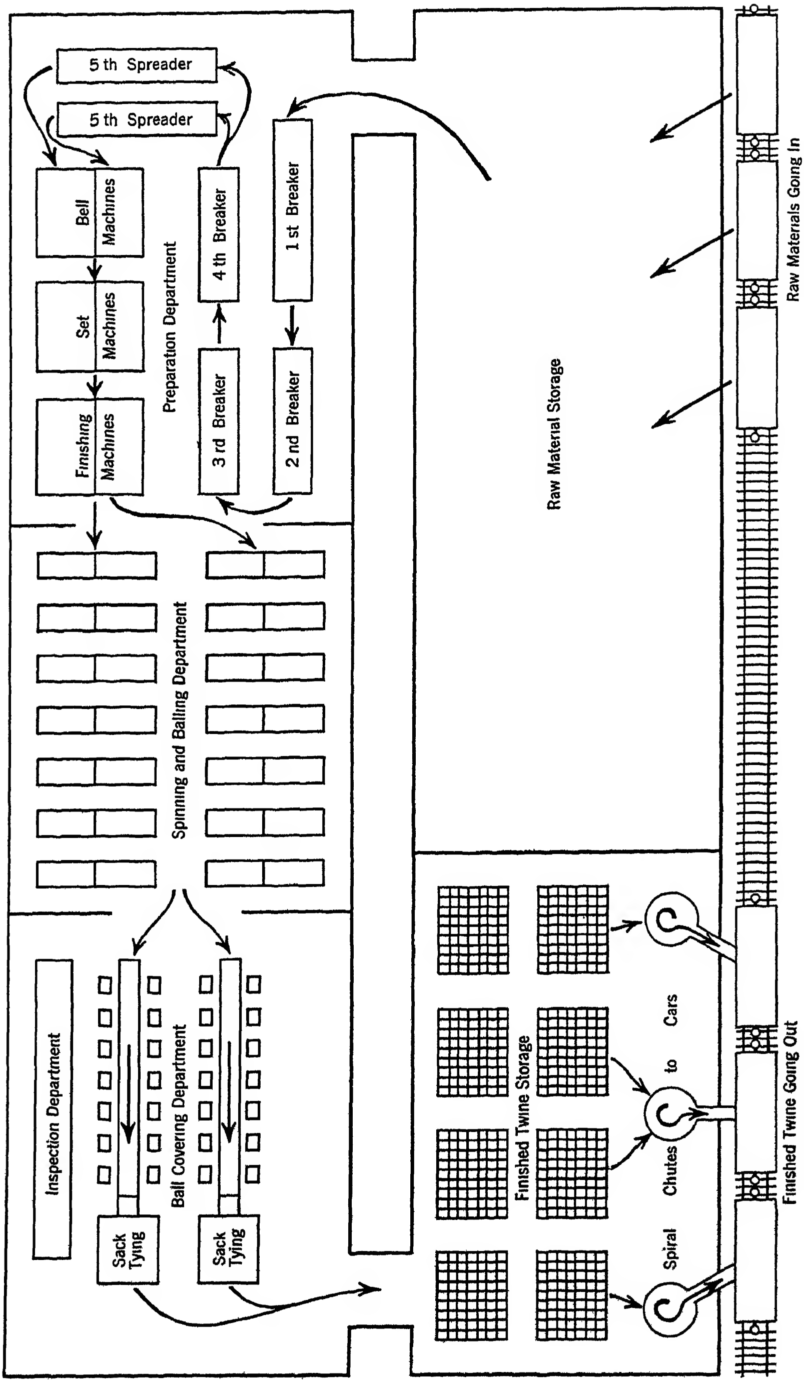
At first glance this would seem to be an ideal layout, and it is for certain qualities of wallpaper of which large quantities are run. In order to make effective use of man power in a multi-line plant the work of each man is arranged to cover the same operation on four lines of equipment. Since it takes several hours to change from one style to another, in practice the worker is attending only three machines at a time, the fourth one being down for a change-over. This arrangement of the men is satisfactory for all operations save the final one of tending the automatic roller, which requires the constant attention of one man. Furthermore, the automatic rolling machines can be operated at a higher speed



Courtesy "Factory Management and Maintenance."

FIG. 24. End of Final Assembly, Easy Washing Machine Corporation, Syracuse, N. Y. (Note overhead power line used in the running test before the completion of the assembly.)

than most of the other machines. It has therefore been found efficient, particularly when running the slow speed (high quality production) set-up, to remove the embossing and automatic rolling machine from the line and to perform these operations in a separate unit as shown in the lower lefthand corner. When this is done the rolls come from the main line in the form of "Jumbo" reels which are transported to the embossing and rewinding unit where these giant reels are rewound into the small consumer rolls. These small rolls are then bundled into units of 15 or 25 rolls and transferred to stock awaiting shipment. This breaking up of the continuous process gives better loading of the mechanical equipment and



Courtesy International Harvester Company, Chicago

FIG 25. Flow Chart of McCormick Twine Mill, International Harvester Company, Chicago, Ill.

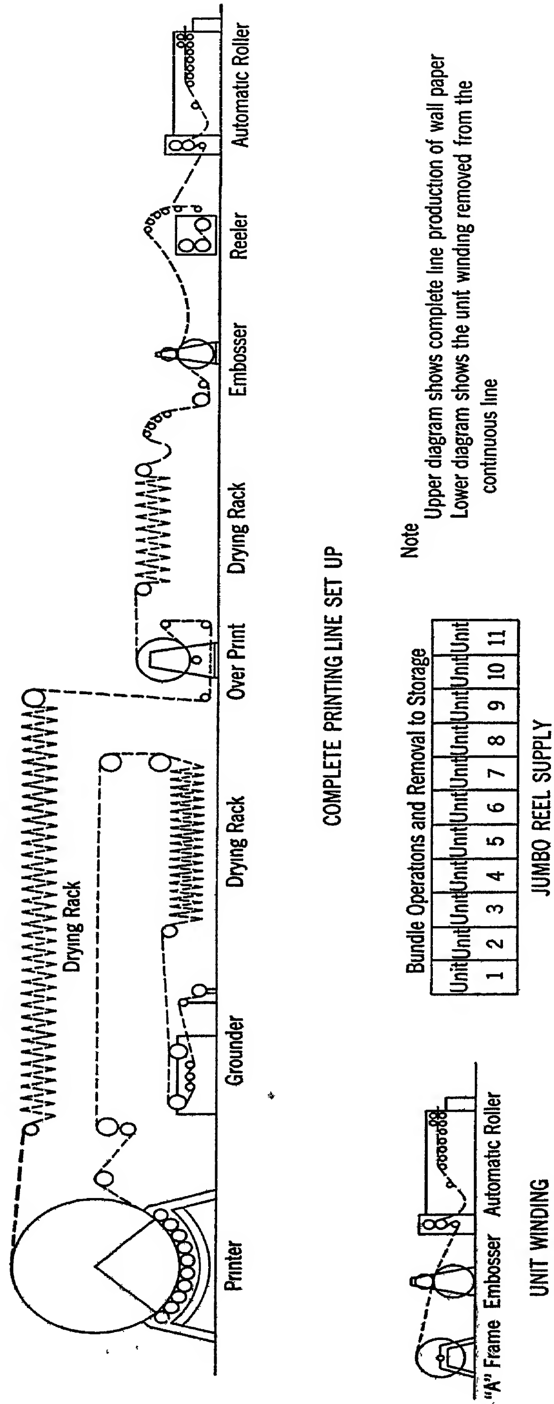
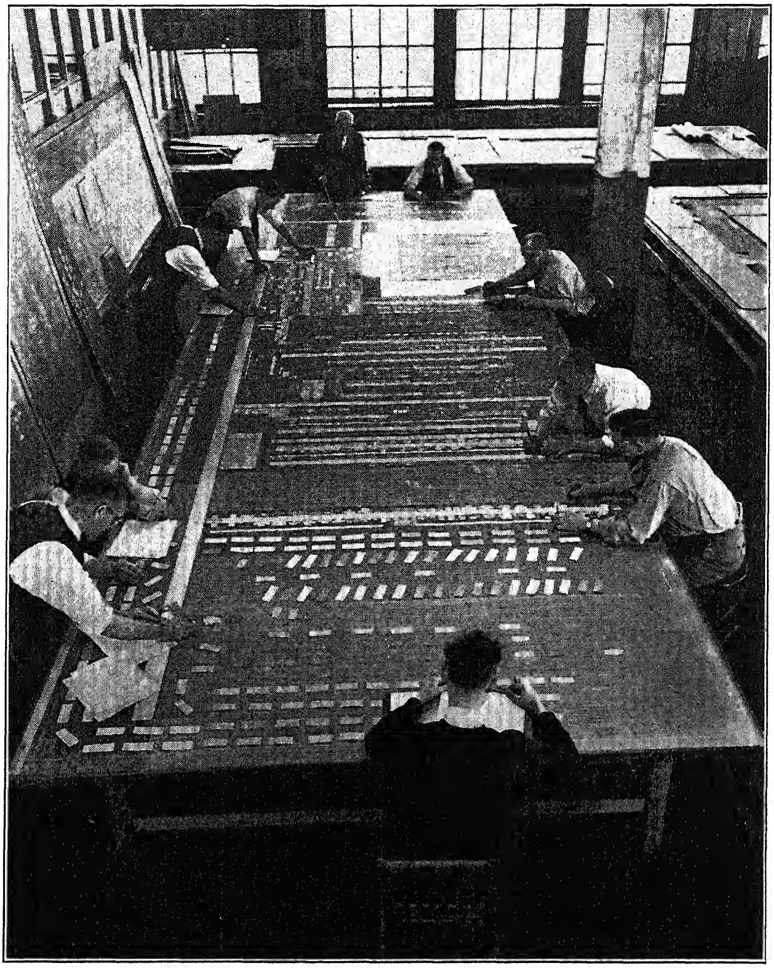


Fig. 26. Wallpaper-printing Layout.

is more efficient for the short runs and the slower speed production even though there is an additional operation involved.

Making the layout. In making the actual layout for a plant it is most important to have complete information at hand before the layout



Courtesy Packard Motor Car Company.

FIG. 27. Packard Motor Car Company Plant Layout Board.

is made. By this is meant all such information as size of production centers, sequence of operations or flow chart, size of storerooms needed for raw materials, partly finished and finished products, space needed for tool rooms, auxiliary equipment, office and production department requirements, aisle space, recreation rooms, service centers, boiler- and

engine-room requirements, and all other similar departments or facilities requiring space. Every required square yard of space must be estimated before final plans are prepared. Future expansion must always be borne in mind and provision made for it. A frequent mistake is that of not providing for expansion or not providing enough space really to fill future needs.

With such detailed knowledge at hand, together with a recollection of the ideals for plant layout, and with the building construction expert always available for consultation, one may proceed with the actual layout. An excellent method is to make, of cardboard or paper, small, scaled templets representing each machine or group of machines in the process. These should be laid on an outline plan of the building drawn to the same scale. (See Fig 27 for an actual illustration from the Packard Motor Car Company.) By this means the almost invariable changes and shifts in plan may be made without expensive and time-wasting drafting work.[3] These shifts are necessary in almost every case. It is best to proceed very cautiously, looking at all times for the unexpected difficulties. When the templets are completed and approved, the whole may be transcribed to blueprints.

The Factory Building

The factory building is the primary tool with which to carry on production and into which all other production tools and mechanisms must fit. Like all other tools the factory building must be adapted to the operations to be performed if these operations are to be most effectively carried on. Defects in factory building construction are often so primary and organic as to make it almost impossible to remedy them after the building is constructed and production has begun. Hence building defects are often of more continuing importance than many disorders in other phases of management which can be made to respond to executive treatment. An ineffective plant creates a burden in all the daily operations of the business.

The ideal modern factory building is developed after all processes are thoroughly considered and related one to another and to the plot of ground which is available. The building is then designed so as properly to house these processes. Flexibility in a factory building is a highly

[3] Mr. H. K. Ferguson of the H. K. Ferguson Company, Cleveland, Ohio, in an address before the American Management Association, November 15, 1939, in Chicago, reports, "My own high mark to date is the making and testing of thirty-four alternate layouts for one plant, before arriving at the one, and only one, extremely simple and clean-cut arrangement which most nearly harmonized the ideal and the practicable layout in all particulars."

desirable objective. Changes in process and product are constantly taking place. Therefore, though a building should be suitable for the purpose for which it is constructed, it should not be too highly specialized

Limitations to plant investment. One of the most difficult managerial decisions to make is the fine balance that must be struck between investing the available capital in fixed building assets for ultimate return and in the more immediately needed current assets. It is a safe rule to consider the plant in the light of a production tool. If the cost of purchase or rent of the new plant may reasonably be expected to yield an increased income over and above all expenses with due regard, in case of purchase, for possible changes in both the product and the process then and then only should the step be given further consideration. This rule will eliminate many unwise ventures.

A desire to increase plant investments may arise from several sources, a few of which are as follows:

1. Sales are in excess of the productive capacity of the present plant.
2. The present plant is not well adapted to the needs of the manufacturing process.
3. Freight rates for the finished product to certain of the market areas are excessive and it is thought advisable to locate a plant, usually an additional plant, in the market area.
4. A desire to have the newest, pride in ownership.

If the present plant is not well adapted to the manufacturing process, costs should be compiled to see if the expected manufacturing advantage will justify the increased expenditure. It frequently will not. It is seldom good judgment to build during the peaks of business prosperity since costs are always excessive. It is difficult for an aggressive management to say "no" after several prosperous years, yet this is most often the most opportune time to postpone additional commitments in buildings.

Building additional plants in another area raises nearly all the problems of management such as methods of control, availability of managing personnel, expectancy of continued sales volume, etc. It requires much more than available funds to run successfully more than one plant. A shortage of trained executive personnel may readily be the controlling factor in not deciding to expand at a given time.

While a desire for the newest is commendable, it is no justification for permanent commitments in buildings unless these buildings will yield returns commensurate with the expenditures involved. This principle is essentially sound even though funds are available for the expenditure.

Size and type of factory building. The selection of a given size or type of factory building is dependent on many considerations, is dependent upon the application of ideals of layout as previously considered, and is also dependent upon the location which has been selected for the

factory. Frequently the selection of the plant location will be partly dependent upon factory layout. For instance, if it be determined that a series of small, scattered units is preferable to one large plant, this would most certainly mean that a suburban location would be carefully scrutinized before being selected since small plants as a rule are better adapted to the cities or larger towns. The type of building to be erected and the ground space to be occupied are very likely to affect location. As in most management decisions involving policy determination, it will be found that there must be an interrelationship of the factors concerned, and that location, layout, size and type of factory buildings are linked up, each with the other.

These phases of the factory housing problem are very closely associated with the problems of organization. A basic change in the method of housing an enterprise should generally result in necessary changes in the construction of the organization, in order that supervision may be made most effective. Conversely, a change in organization may at times make it desirable that certain physical aspects of the factory building be modified. For instance, if it is decided to place several departments under the control of one superintendent, it is desirable that these departments be so located that the superintendent may be accessible easily to the foremen of the departments, and that he in turn be able to visit the foremen without the loss of too much valuable time.

How large should a factory be? It has been concluded frequently that the larger a factory grows, the more economies of operation through mere size can be effected. Merely because there are distinct advantages inherent in large-scale operations, it does not always follow that such operations must be carried on at one location. There are many advantages in the huge multi-acred plant which has come to be looked upon as typical of the new industrial day. On the other hand, we see everywhere about us, in industries which permit, small plants which are not only able to compete with their huge rivals, but which frequently produce far larger returns per dollar of invested capital. How is that possible in these days of large-scale production, integration, and control of markets of raw material and finished product? The answer lies almost entirely in the management problems involved in operating the large plant and those involved in operating the small plant. The small plant has certain very definite management advantages which have caused managers of large plants to question the limits of economies from large plants and ask, "How large should a factory be?"

Size and type of building will be seen to be directly related to the establishment of functional departments. If these departments are established they must of necessity be so located as to make possible immediate contact with all portions of the line organization of the busi-

ness. This is particularly true of a central planning department. If staff departments be organized, they may cause the erection of one large plant, so constructed and laid out as to give them complete opportunity for contact. If a number of small buildings are established, effective action from the staff departments is more difficult To have such a department represented in each of the buildings probably would entail overhead expenditures which would be likely to defeat the whole purpose of the department.

There is a difference in the personnel problem in the large plant and in the small one. No matter how effective the organization steps, committees, or leadership, in large plants, it is impossible for the worker to be in actual contact with the men really running the plant. Many management devices have been instituted for the single purpose of minimizing this impersonal relationship in so far as it is possible. Small plants can eliminate these devices. The close relationship between the head of the organization and the worker, that has passed so largely out of industry with the coming of the big corporation, has led to the survival of the small company in many individual cases.

Under present economic and industrial conditions times of depression seem to be inevitable and constantly recurrent. This should influence directly the size of the plant. Businesses which have several plants are enabled to shut down one of these entirely at such times. Businesses that have but one big plant must shut down a portion of that plant. This latter course means that the workers throughout the organization are affected because of the shutdown of one small section of the business. They see other men and women thrown out of work, and they naturally ask, "Aren't we next?" or "Shouldn't we decrease our production so that there will be enough for all of us?" Knowledge may come to plants that are still running concerning other plants of the same company which have been partially or completely shut down, and this may affect production slightly in an unavoidable way; nevertheless, the effect is far different from the shutdown of a portion of the same factory. In the latter case the workers who remain know large numbers of the workers who have been laid off; the whole action is so close that they necessarily feel that they are "next."

Industries manufacturing large or heavy products with nation-wide distribution are always face to face with the freight-rate disadvantages inherent in one large plant, no matter how central its location may be. One of the best examples of a method of coping with this problem, and one that has been largely emulated, is that of the Ford organization. The idea of assembly plants in many parts of the United States, with the product shipped to them from the main factory in knocked-down condition, and the consequent saving of the freight involved, proved so

successful that it was not long before the example was followed by other automobile companies and other lines of industry. An example of this same idea in another industry is to be found in the utilization of "fabricating shops" by steel manufacturers. More or less rough shapes are shipped to locations near the big cities or other centers of consumption, and are there worked over, or "fabricated" in accordance with the needs of the local community.

Type of building. Whether the factory building should be one-story or multi-storied is a basic problem. The lowest cost per square foot of floor space can be secured usually through the use of three- to five-story structures if the ground be relatively high in value. Otherwise the lowest cost may be found in one- or two-story structures. With the addition of stories above five or six in a factory employing many workers, the cost per square foot of usable space is likely to increase rapidly, because the effective area is reduced by the service features, such as stairways, fire-towers, and elevators. The cost of foundations and the space occupied by supporting columns also increases with the number of stories. For light material, such as hosiery, a multi-storied building is usually preferred. (See Fig. 20.) Multi-storied buildings have distinct material-handling advantages where goods can be moved by gravity. (See Fig. 28.)

In suburban or smaller city locations where land is relatively cheap, the one-story plant is often favored, particularly if heavy machinery be used in the processing or if the materials or product be heavy. The maintenance cost arising from the vibrations of machinery operations is largely eliminated in the one-story building, the machinery being set on especially prepared foundations.

Layout problems for processing heavy materials are simplified when consecutive operations are placed at adjacent workplaces. This can be accomplished more readily in one-story structures (Fig. 29).

Some departments grow more rapidly than others, a growth which often cannot be foretold at the time of laying out the plant. The one-story plant provides greater flexibility in meeting this condition. Furthermore, provision for the use of natural lighting can be more readily arranged in the one-story plant than in the multi-storied plant.

Figure 30 illustrating the plant of the Westinghouse Air Brake Company indicates the manner in which different types of structures are utilized in the same plant to provide the necessary housing for the diverse foundry and machine shop operations of this particular business.

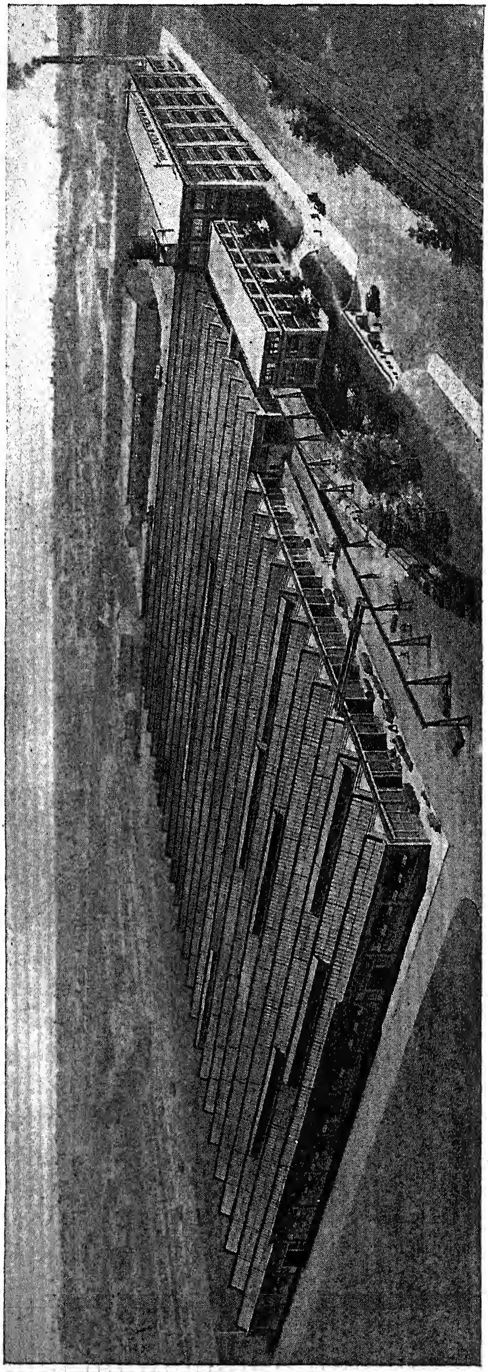
Provision for adequate natural light. The provision for adequate natural lighting is directly related to the construction of the building itself. It is affected by such considerations as the nearness, character, and color of adjoining buildings, the height and width of the individual

rooms, the provision of open courts in the layout of the plant, and the type of construction, insofar as that affects the amount of window space that can be secured.

Courtesy Stone & Webster, Inc.

FIG. 28. Bag-filling Machines showing use of Gravity in Layout of Sugar Refinery. The American Sugar Refining Company, Baltimore, Md.

Natural light illuminates either by direct rays or by reflection from various surfaces either outside or inside the factory building. Provision

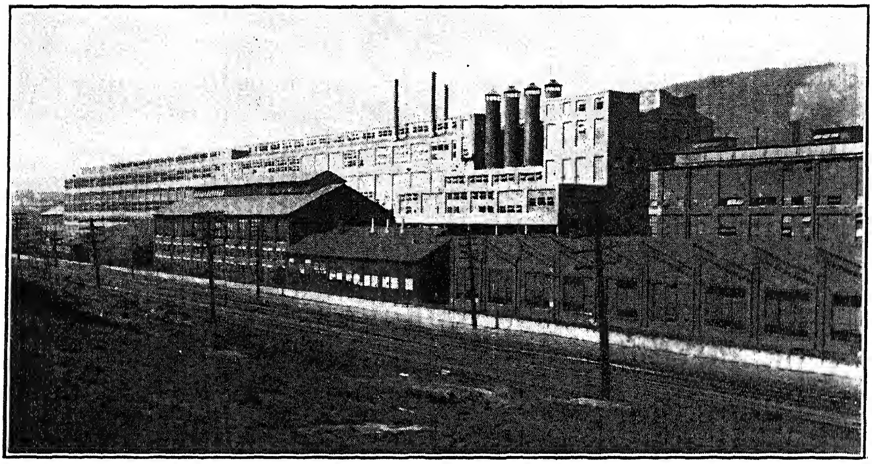


Courtesy Proctor & Schwartz.

Fig. 29. A One-story, Saw-tooth Building, Proctor & Schwartz, Olney, Philadelphia, Pa.

for natural lighting must take into account these reflections. The illumination given by daylight is general in that it tends to spread throughout the whole room, but its intensity is seriously decreased towards the center of the room unless light is admitted through windows in the roof.

Newer types of factory buildings have as nearly 100 per cent of their walls constructed of steel as practical. The development of steel window



Courtesy Stone & Webster, Inc.

Fig. 30. Westinghouse Airbrake Co., Wilmerding, Pa. (A large plant using a variety of types of building construction. Note the saw-tooth roof in the lower right-hand corner and the monitor roof in the front just to the left of the center.)

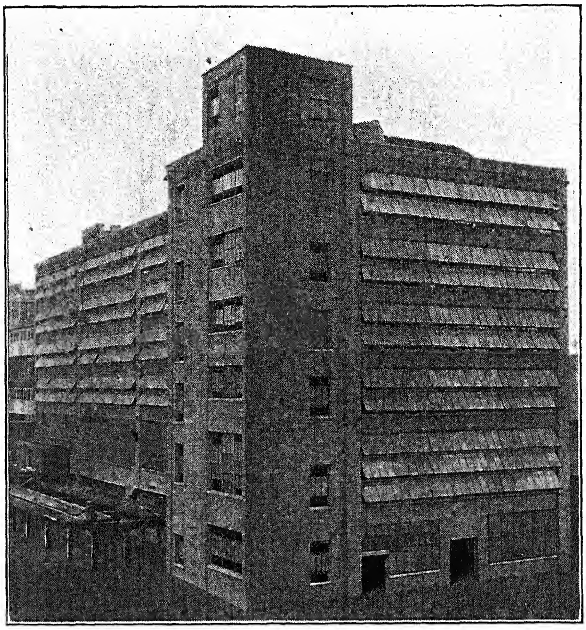
sash has greatly increased the amount of daylight that may be admitted. These windows may be opened individually or as a group. (See Fig. 31.)

The amount of natural light that reaches the interior of a factory workroom is dependent on the relationship between the height of the windows and the width of the room unless there be roof windows provided to supplement the light from the side walls. If windows are on one side of the room, adequate light will be available for a distance twice the height of the windows. If windows are on two sides of a room, light will be available for a distance equal to about three times the height of the windows. Tables are available to show the amount of daylight available at different distances from windows with different window heights. In multi-storied buildings the height of the windows on the lower floors is often made greater than the upper floors to insure adequate illumination if surrounding structures cut off the light. As a rough rule it has been found that poor lighting will result if the ratio of floor space

to window space is greater than six to one. In modern "daylight" factories, the window space is from one-third to one-fifth as large as the floor space.

Glass bricks and tile are available for use in side-wall construction. For certain purposes these have been used effectively. The cost is somewhat greater than present standard constructions; however, they have genuine merit in structures where use is made of natural light in combination with mechanically-controlled ventilation and temperatures.

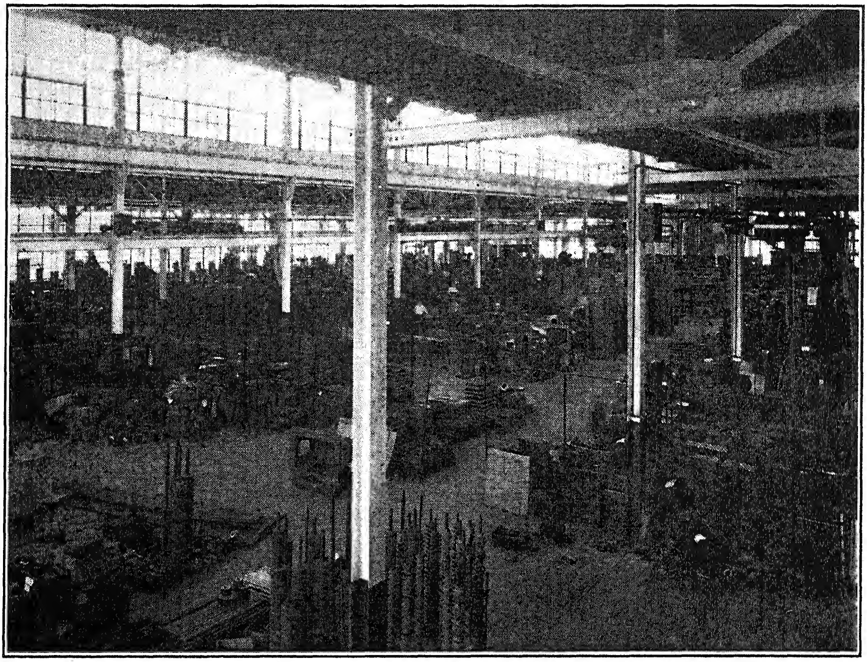
Roof lighting. One-story factory buildings are often constructed to provide some roof lighting in addition to the light from the wall windows. These roof windows are of three types, namely, skylights, monitor roofs containing either vertical or sloping windows, and saw-tooth roofs containing either vertical or sloping windows. Skylights usually have the glass placed in nearly a horizontal position, and consequently get dirty very easily. They therefore do not remain efficient transmitters of light for long unless washed very often. Monitor roofs provide nearly ideal daylight conditions for factory interiors. (See Fig. 32, National Automatic Tool Co.) It is easy to keep monitor roof windows clean. They can be so placed as to give maximum light at the point midway between the side walls where light from the wall windows is least. Wide monitors, at least one-half of the width of the building, are most efficient if single monitors are used. In any case the width of the monitor should not be less than twice the height of its windows nor the height be more than half its width. Increasing the height of a monitor increases the maximum illumination available and sloping windows at times will increase the light at the point most needed. Saw-tooth roofs with the sides contain-



Courtesy David Lupton's Sons Co.

FIG. 31. A Daylight Factory, Firestone Tire & Rubber Co., Mechanical Building, Akron, Ohio.

ing the windows facing north to secure a minimum of direct light rays are widely used in natural lighting. Narrowing the span of the saw-tooth or increasing the height of the windows in the saw-tooth increases the uniformity of light distribution.



Courtesy Detroit Steel Products Co.

FIG. 32. Interior, Plant of National Automatic Tool Co., Richmond, Ind. (The monitor roof provides a craneway for handling heavy material and gives good natural light.)

Types of building construction. The various types of factory building construction used may be classified as follows:

1. All wood or typical light frame building.
2. Structural steel with hollow tile, brick, concrete, or corrugated metal walls.
3. Reinforced concrete.
4. The slow-burning heavy wooden or mill construction.

The structural steel building has the skeleton of steel and the walls and floors of some other suitable material. The reinforced concrete building is built of concrete and reinforced throughout with steel. The mill construction is built of heavy wooden columns, joists, and other structural members. It was popular when wood was plentiful but is seldom used

today. Adequate sprinkler systems must be provided for protection against fire.[4]

The construction used in partitions greatly influences the flexibility of the plant. The tendency is to have as few supporting columns as possible and not to use partitions as a part of the building support. In this case room partitions and fire walls are often built of hollow tile which can easily be removed and rebuilt as changes in layout require.

Maintenance of the factory building. Proper attention is as necessary to the maintenance of the factory building as to the machinery, yet such is often not the practice. Roofs are repaired if they leak and floors are patched when they actually cause trouble, yet proper maintenance will nearly always minimize costly repairs and give more effective service. Interior painting is often neglected in factories long after the place has been reached where interior lighting calls for action. The percentage of light reflected from the walls and ceilings varies in general with the material and color according to the following table:

TABLE 1

PER CENT LIGHT REFLECTED FROM TYPICAL WALLS AND CEILINGS *

Surface	Class	Color	Per Cent of Light Reflected
Paint		White	81
Paint		Ivory	79
Paint	Light	Cream	74
Caen Stone		Cream	69
Paint		Buff	63
Paint		Light Green	63
Paint	Medium	Light Gray	58
Caen Stone		Gray	56
Paint		Tan	48
Paint		Dark Gray	26
Paint		Olive Green	17
Paint	Dark	Light Oak	32
Paint		Dark Oak	13
Paint		Mahogany	8
Cement		Natural	25
Brick		Red	13

* Source of data: *Westinghouse Illumination Handbook* (New York: Westinghouse Lamp Company, 1934), p. 14.

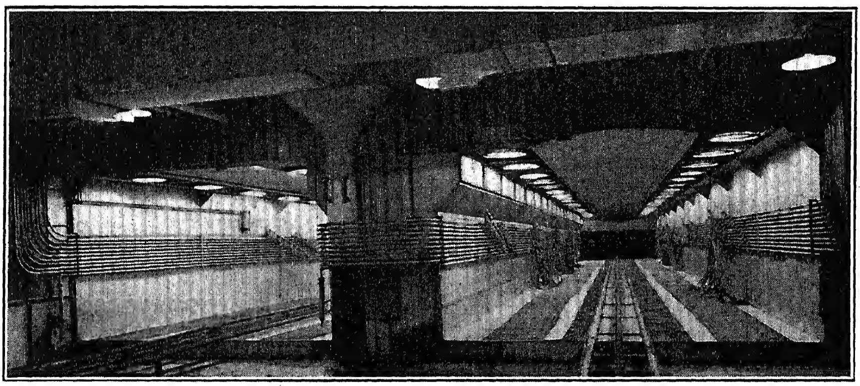
[4] See Fernstrom, Elder, Fiske, Schaefer, and Thresher, *Organization and Management of a Business Enterprise*, Harper and Bros., New York, 1935, pp. 244-252, for a good discussion of building construction.

Although a high gloss on a painted wall reflects more light than a dull finish, it is frequently unwise to use it on the walls when workmen face the wall because of the glare in the workers' eyes. Adequate records of maintenance expense will often point to better materials for use in various parts of the plant. This is especially true in the case of floors that carry heavy traffic. In the larger plants a special foreman or superintendent devotes all of his time to the problem of plant maintenance.

CHAPTER X

MATERIAL-HANDLING METHODS

The importance of material handling in plant layout, and as a factor in modern industrial processes, has already been suggested. It constitutes one of the largest items of cost in modern manufacturing. Material handling can be reduced somewhat by proper layout, as through the use of assembly lines (see Chapter IX), but it cannot be wholly



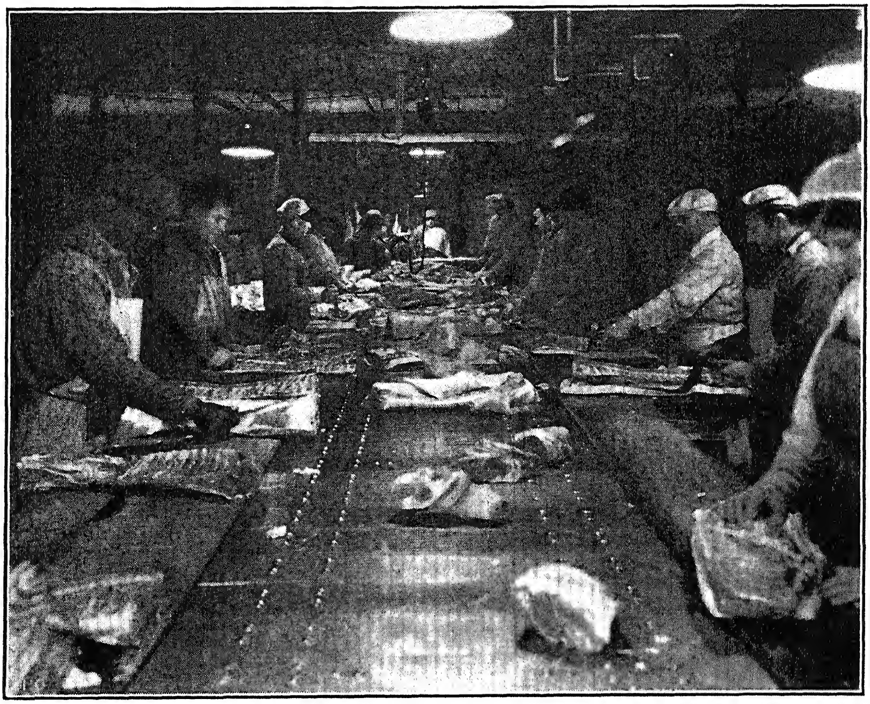
Courtesy "Steel."

FIG. 33. Circulating paint to spray booths through pipes illustrates a modern material handling method in automobile body plants. Standardized materials, as well as lower handling costs result.

eliminated. In recent years modern material-handling methods have reduced these costs greatly, but further economies through the use of recently devised mechanisms will doubtless make these savings only a beginning in the near future.

Some material-handling devices make for improved layout by connecting widely separated parts of the factory (see Fig. 35); some improve the technique of the process itself (see Fig. 33); some make possible an increase in the weight and size of the unit of production (see Fig. 47); while some assist in shipping the final product (see Fig. 50).

The first developments in mechanical handling included overhead cranes, jib cranes, and locomotive cranes. Overhead cranes still play an important part in material handling within our manufacturing establishments. Figure 36 shows a craneway in the Twin Cities Manufacturing Plant of the Ford Motor Company. It will be seen that in this craneway, freight cars are brought directly within the building, and their unloaded cargo can be transported to any part of the bay by the cranes.

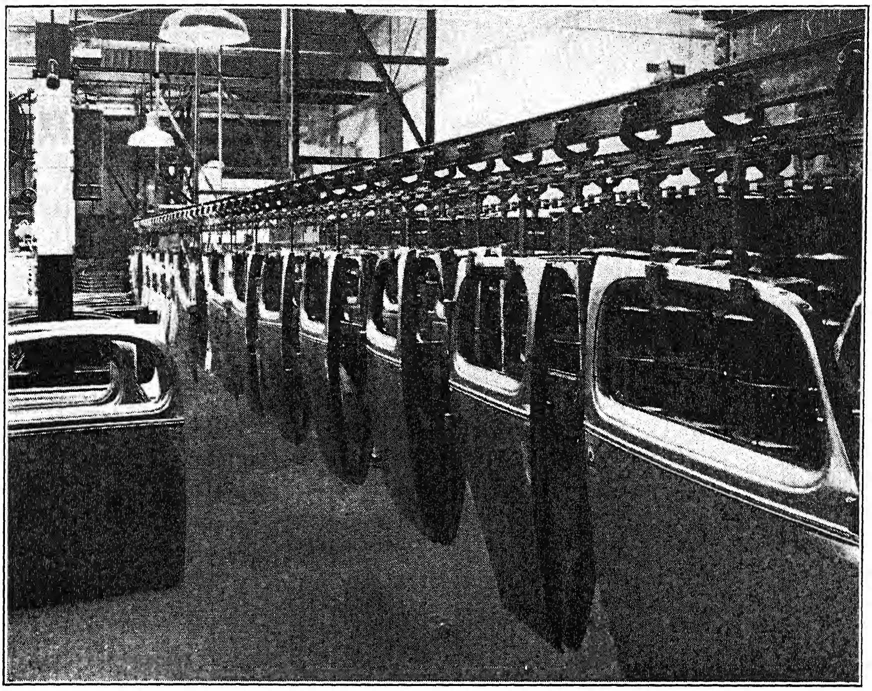


Courtesy Westinghouse Lamp Co.

FIG. 34. Meat Cutting on a Conveyor. (150-watt white bowl lamps with R. L. M. Reflectors produce 12 foot-candles on the table. Adequate light is needed for this hazardous operation.)

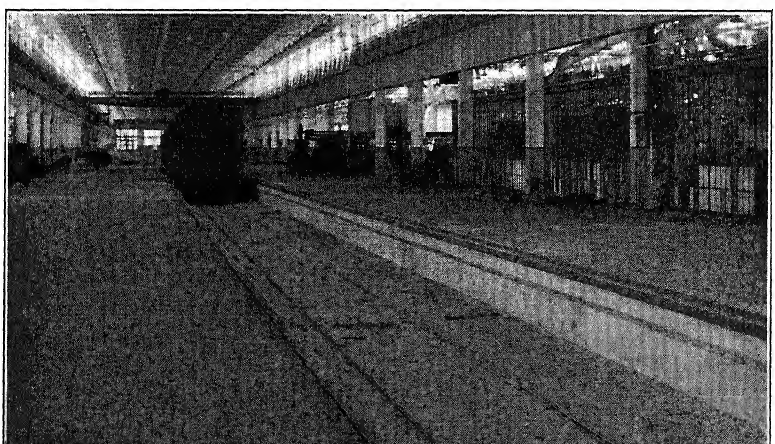
The floor is at the level of the car doors. In heavy manufacture, the selection of a site that allows railroad tracks to be placed through buildings, and railroad freight cars to be spotted at any desired point, from which the material may be handled by cranes, is an important feature of plant location. Layout of buildings with due consideration of the permissible curves of railroad tracks is an important element in material handling within such plants. (See Fig. 37.)

Mechanical unloading devices, such as those illustrated in Fig. 46,



Courtesy "Automotive Industries."

FIG. 35. Handling Car Doors, Oldsmobile Plant, General Motors Corporation.

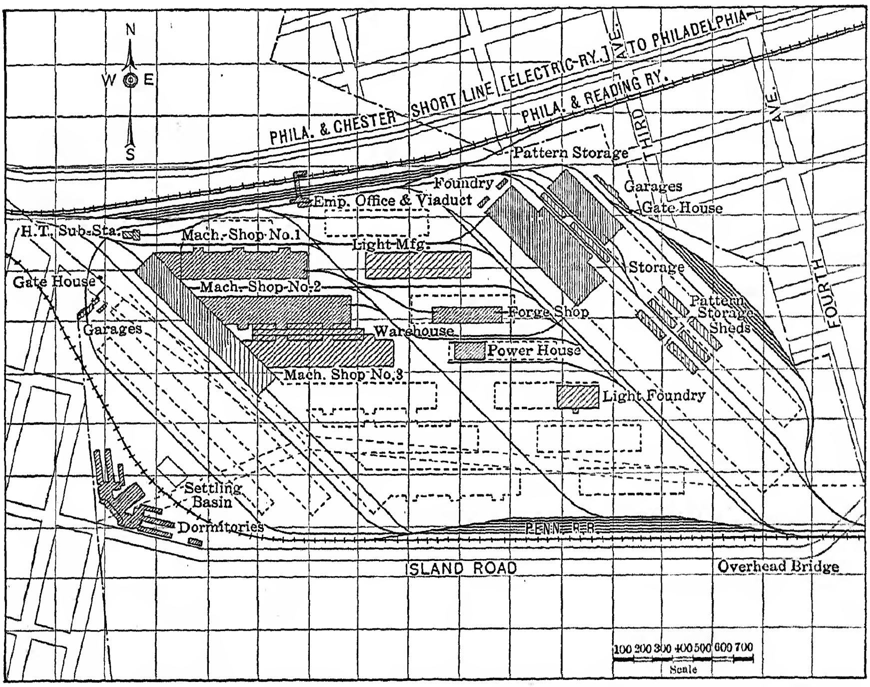


Courtesy Stone & Webster, Inc.

FIG. 36. Interior Twin Cities Factory, Ford Motor Company. Note height of floors even with car doors.

form an important means of saving labor in material handling. In the conveying of bulk goods, such as lumber, and package goods, such as those in Fig. 50, standard equipment may be used, the only needed adaptation being that of securing proper lengths.

Tiering machines (see Fig. 49) and other equipment for handling materials and products in the storeroom have become an essential part of such departments during recent years. Not only do such devices save labor, but they allow the materials to be stowed to a greater height.

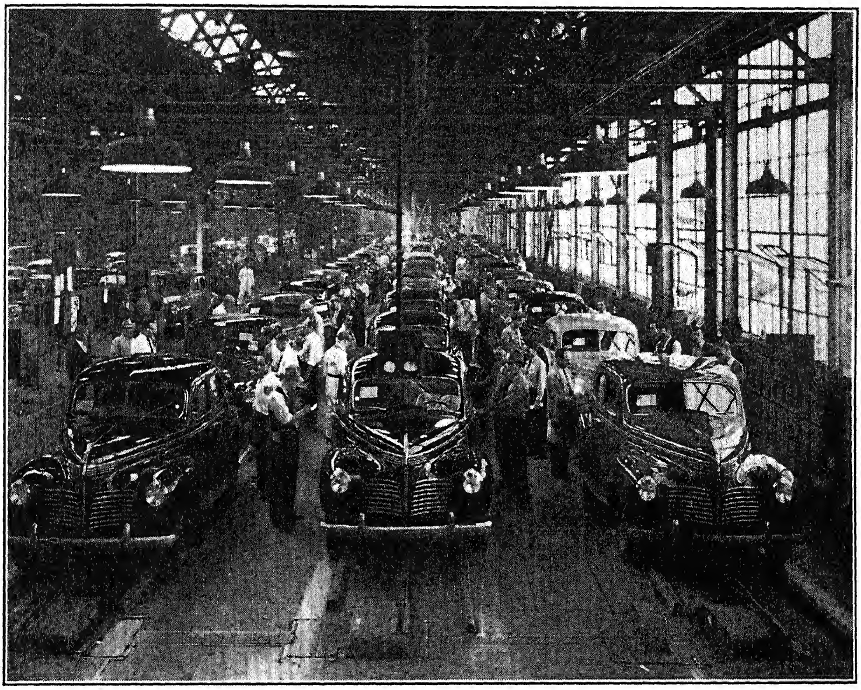


Courtesy Westinghouse Elec. & Mfg. Co.

FIG. 37. Layout of Westinghouse Electric & Manufacturing Co., South Philadelphia Plant, Lester, Pa.

Material handling and plant layout. A reciprocal relationship exists between plant layout and material handling. The method of handling materials definitely influences the plant layout and the plant construction and layout limits the method of handling materials. When materials are moved by hand-operated or power trucks, aisles must be provided for their use. (See Fig. 15.) When materials are moved by overhead cranes, as is largely the case in the A. O. Smith automobile frame plant of Milwaukee (when not being moved as a part of the continuous fabricating process on the conveyors), aisles are largely missing, but the over-

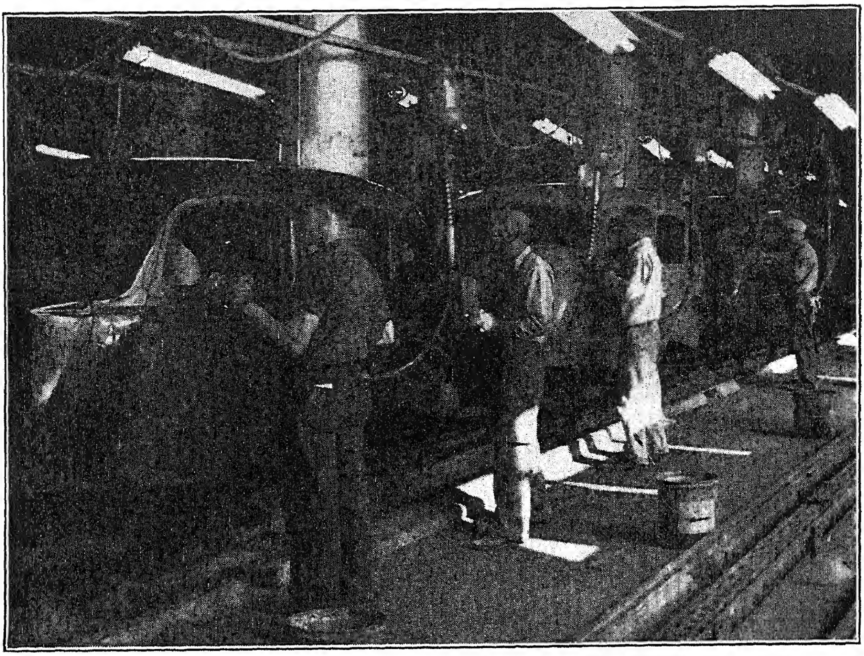
head space must be unobstructed. When materials are moved by pipe lines or ducts, such as paint in automobile body plants (Fig. 33), and shavings and sawdust in woodworking plants, provision must be made for these methods of transportation. Multi-storied buildings may require elevators or lift-conveyors of a different construction than the material-handling equipment required in a single-story building in which the same



Courtesy Plymouth Motor Car Co.

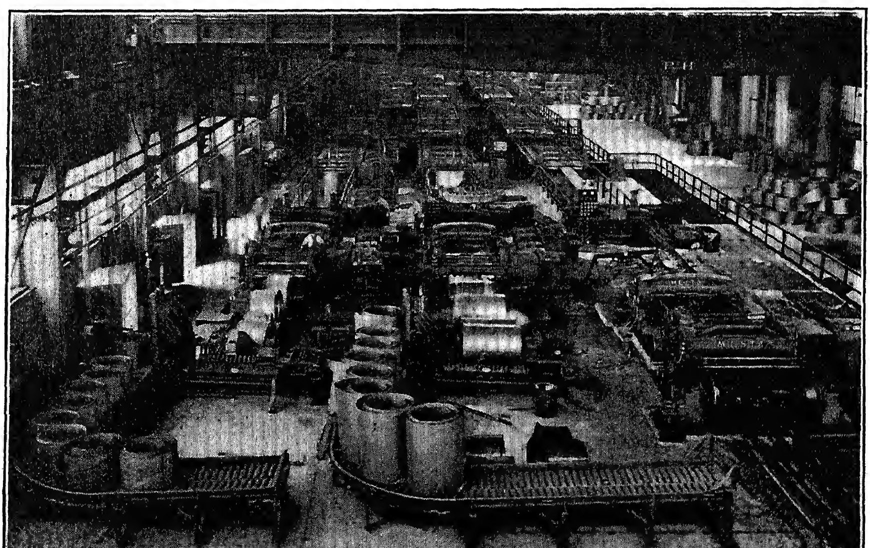
FIG. 38. End of the Ride! (From here every Plymouth is on its own power. Here is where the cars get the final "okay" as they are driven away at the rate of 3 per minute.)

operation is performed. Gravity may be used in moving materials in a multi-storied building, or one built on a sloping grade. Modern material handling techniques make possible a continuous flow of materials and work in process between buildings and from one floor to another, thus removing restrictions of space and building construction that formerly handicapped the industrial engineer's plans. The ideal processing sequence may now be visualized, and by applying the known techniques, it may be largely realized in spite of serious handicaps of building construction.



Courtesy "Automotive Industries."

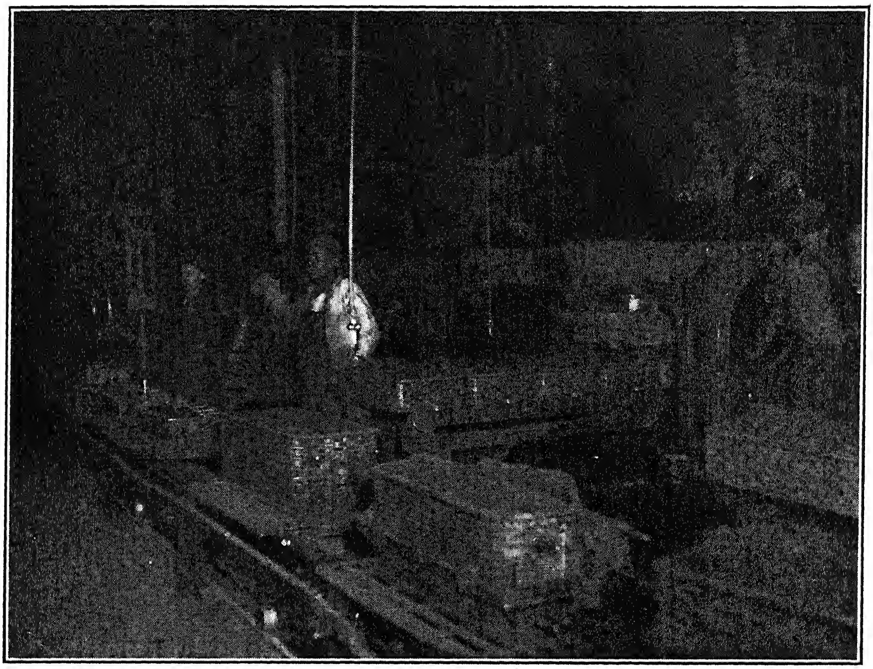
FIG. 39. Performing Finishing Operations on Bodies as They Move on Their Conveyor, Hudson Motor Car Co., Detroit.



Courtesy "Steel."

FIG. 40. Handling Coils of Wide Strip Steel at the Beginning of Modern Continuous Pickling Machines. (The crane and magnet drop the coils on the conveyors which take them to the tilting table. From there they are skidded to the decoilers

Material handling and processing. It is as a direct part of the manufacturing process that material handling has made the greatest strides during recent years. In the cement industry, and in flour mills, simple conveying devices have been an essential portion of the process for many years. The meat-packing industry was one of the first to use mechanical conveyors to support the product while operations were performed upon it. (See Fig. 34.) Such use of conveyors changes the process from an intermittent one to a continuous one, and makes for



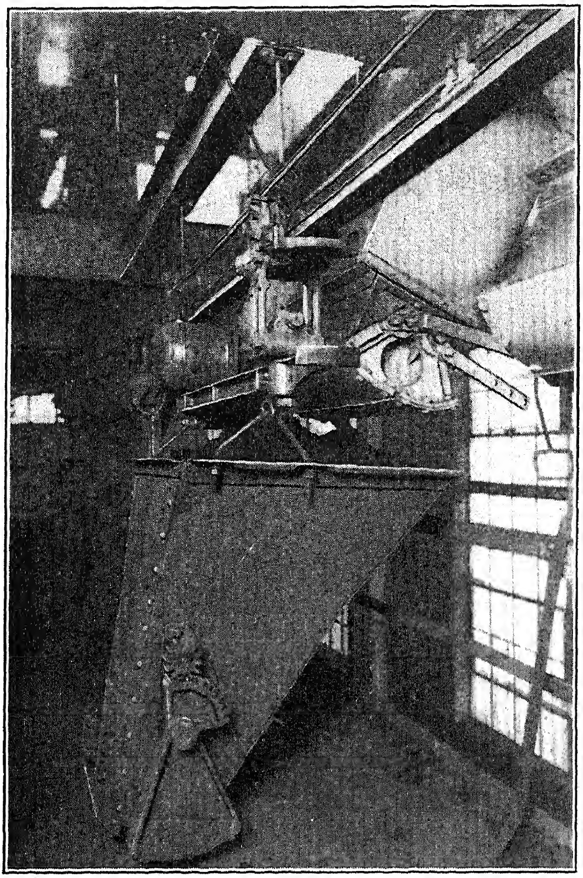
Courtesy "Automotive Industries."

Fig. 41. Molding Machines for Molding Intake and Exhaust Pipes, together with Material Handling Equipment, Buick Motor Car Co., Flint, Mich.

constant utilization of labor and equipment. This use of material-handling equipment is well illustrated by the continuous assembly and testing of washing machines by the Easy Washing Machine Company, Syracuse, New York. (See illustrations, Figs. 23 and 24.)

The rise of the automotive industry brought the opportunity to apply mechanical process conveying of materials on a large and varied scale. At the present time this industry does its processing, whenever possible, as the material moves (see Fig. 39) and has applied mechanical handling to all phases of its material-handling problems (see Fig. 38). The

moving-chain conveyor and its counterparts are the determining factor in the rates and costs of production in this industry. The lowering of prices and consequent enlargement of market which featured the use of process conveyors in the automotive industry is an outstanding de-



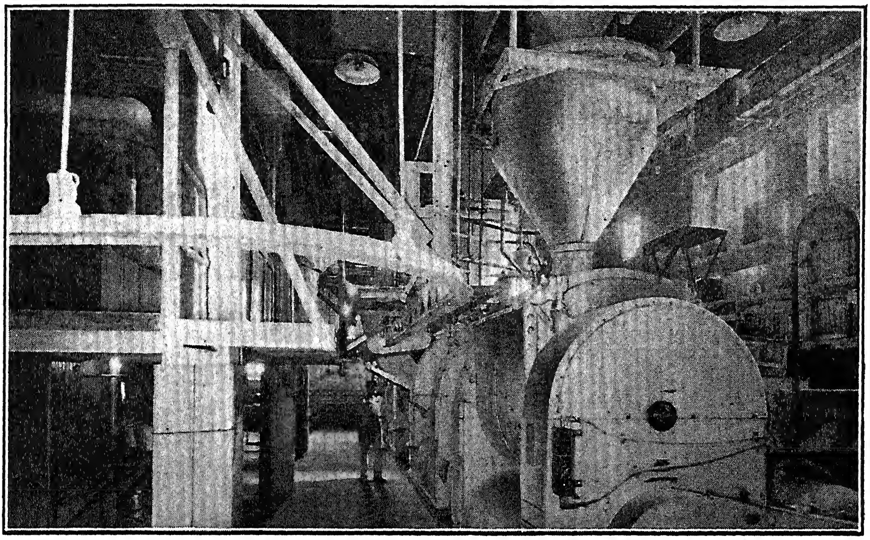
Courtesy The Cleveland Crane & Engineering Co.

Fig. 42. Bucket Unit and Storage Hopper, Iron Foundry. (Old sand is tempered and returned by conveyor to hoppers, then distributed to chutes above the molding machines by bucket units on a tramrail.)

velopment of manufacturing in the twentieth century, and served to make other industries endeavor to perfect production economies in the same manner.

One of the older industries which has been revolutionized recently by the use of mechanical handling equipment is the foundry industry. Older methods called for the use of much common labor here. Although

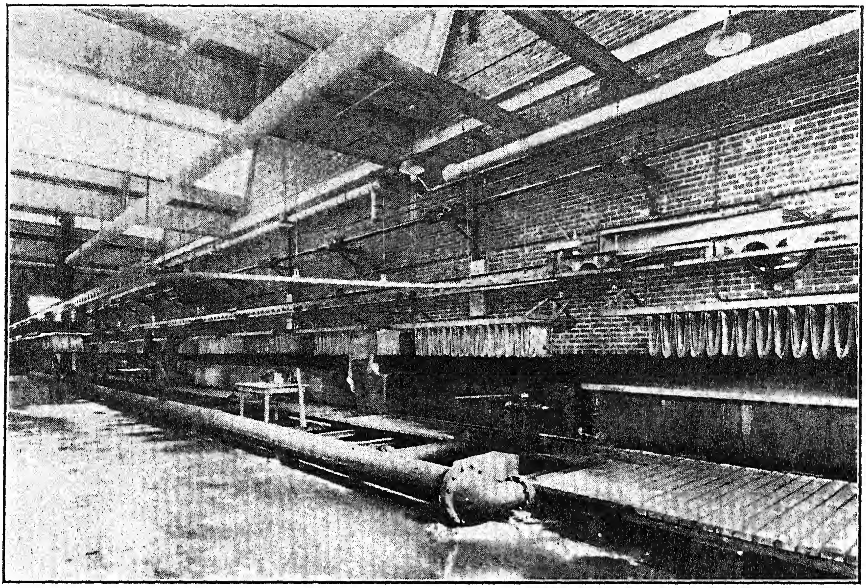
common labor has not been eliminated entirely, it has been greatly reduced. Figures 41 and 42 illustrate the application of process conveying in this industry. The bucket unit and storage hopper illustrated in Fig. 42 are controlled by one man who controls the storage and distribution of all molding sand. In the Buick Foundry, Fig. 41, intake and exhaust pipes are turned out at a speed undreamed of under the old hand-operating methods. The Allis Chalmers Corporation of Milwaukee has also conveyorized the pouring of molten iron into the molds for its large-volume production of castings. Figure 40 illustrates material handling in the steel industry.



Courtesy The Cleveland Crane & Engineering Co.

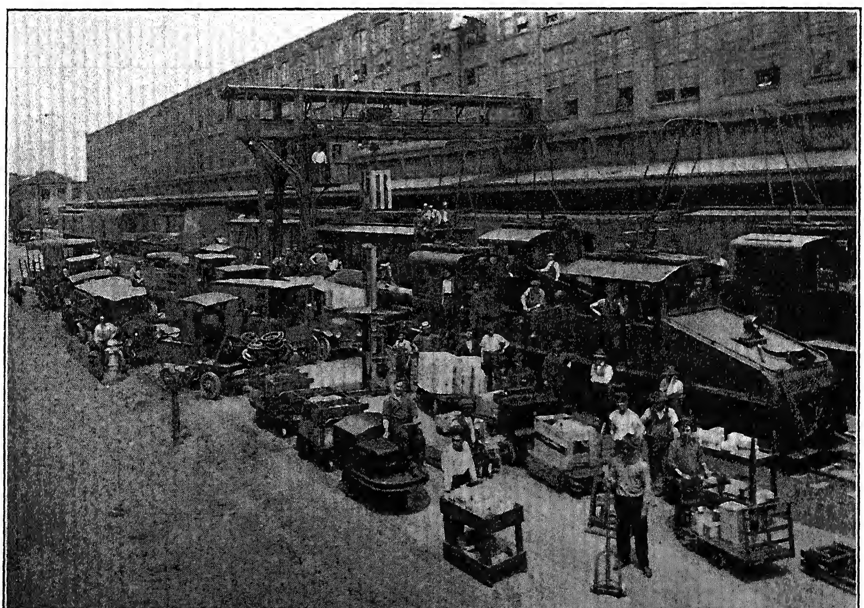
FIG. 43. Dough Trough about to be Dumped into Mixer after being Conveyed from Fermentation Room, Brown's Bread, Ltd., Toronto, Ont.

The application of the process conveyor in other industries is shown in Figs. 43 and 44. These illustrations need little explanation, other than Fig. 44, which shows the application in silk bleaching. The beam shown in this illustration is 120 feet long, and extends over ten vats, each approximately 12 feet in length. The silk must be dipped into each vat for approximately seven minutes. The beam is filled with racks containing the skeins of silk, and lowered into the vats, so that each load goes into its respective vat. It remains in this position seven minutes, after which it is raised, and allowed to drain for two minutes. Immediately after draining, the entire load is moved forward one vat, and a new rack run on to the beam from the right side of the room. The silk skeins are supported on glass rods, which fit into the angle-iron sides of the racks.



Courtesy The Cleveland Crane & Engineering Co.

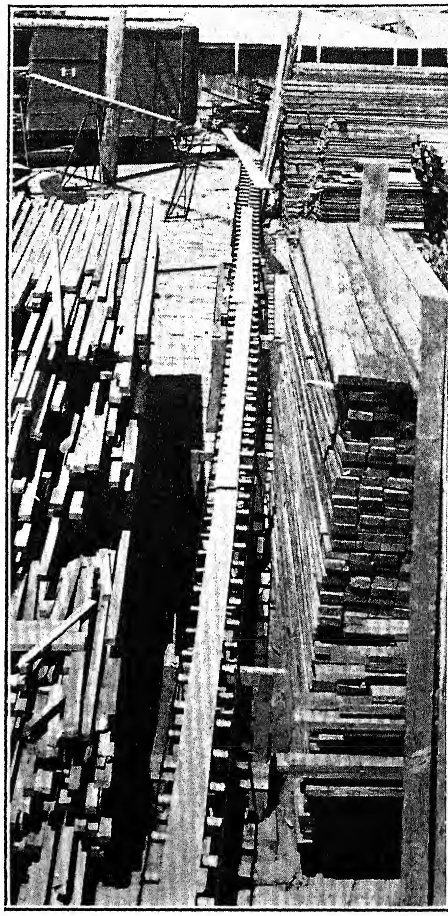
FIG. 44. Silk Bleaching by Mechanical Handling Equipment.



Courtesy General Electric Company.

FIG. 45. Material Handling Equipment Assembled at Schenectady Plant of General Electric Company.

These are turned over by the operator in this installation, so that the entire skein of silk is run through the bleach. In other types of installations, the material is turned by machinery. By this process, each skein of silk goes through exactly the same bleaching process, which would not be the case with hand methods. The beam is now being operated by one operator and four laborers, whereas formerly twenty men were required to do the work.



Courtesy Mathews Conveyor Company.

FIG. 46. Three-rail, Gravity Conveyor, Handling Lumber at the Mox Lumber & Wrecking Company, Los Angeles, California.

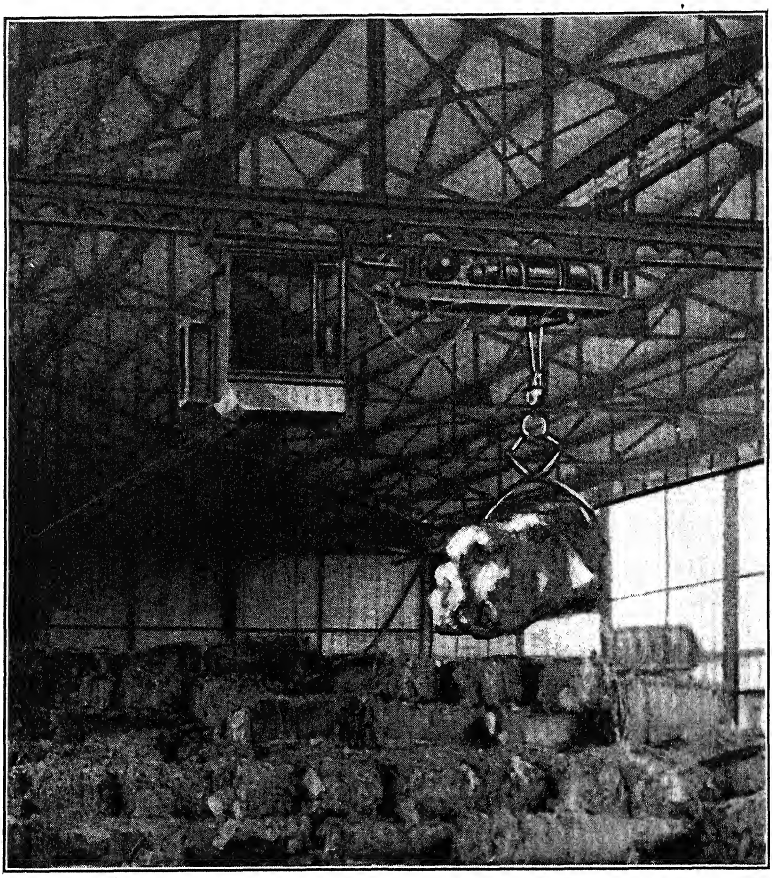
Figure 48 illustrates a simple chute type of conveyor used by the General Motors Corporation to transfer tires from the balcony to the automobile assembly line.

Another form of transporting materials is shown by Fig. 33. This is an ultra-modern method of bringing the automobile paint from the paint storage and mixing room to the spray booth.[1] Automobile body doors are transferred from the door department to the body lines by overhead conveyors, as illustrated by Fig. 35.

Although process conveying is the outstanding feature of material handling today, great strides have been made in other methods of handling materials that have not been mentioned specifically. Figure 45 illustrates clearly the large number of types of material-handling apparatus that are available for specific purposes. Material handling by modern methods is an important factor in the lowered production costs of mechanized industry.

[1] The principle of piping materials is used extensively in external transportation. Gasoline is piped all of the way from the oil fields of the South to Chicago.

Material handling between plants. The long body trailers are familiar sights on the roads between Detroit, Pontiac, and Flint. The haul-away automobile trucks are seen in many parts of the United States. The Ford Motor Company has specially equipped freight cars to handle body stampings and other automobile parts in which they ship supplies

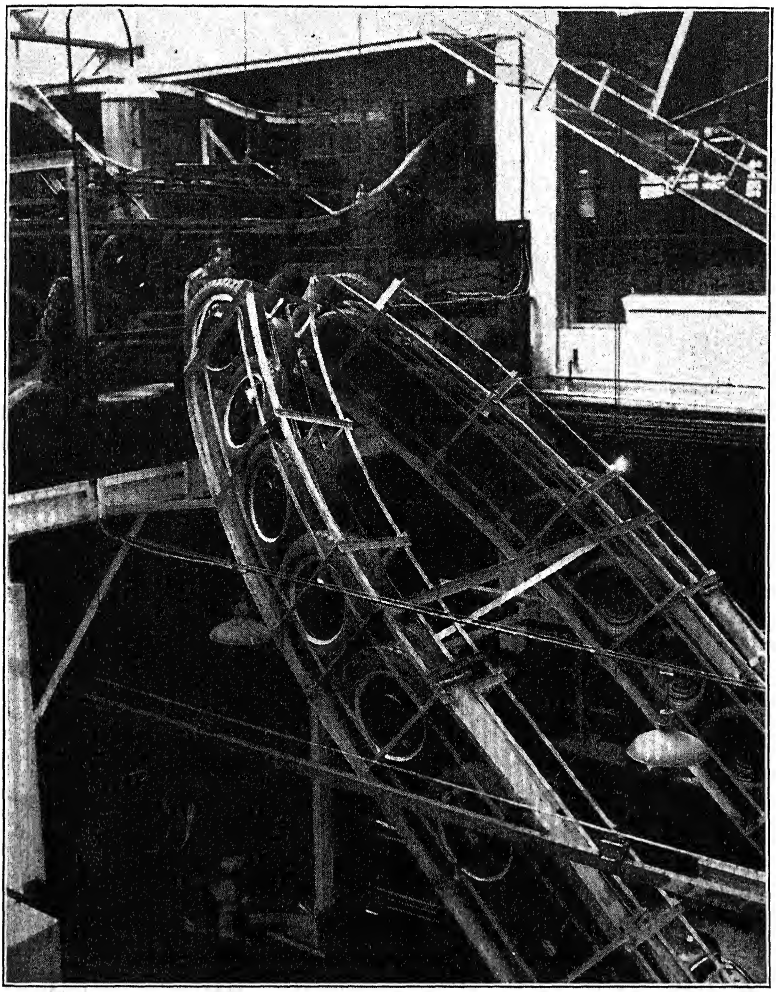


Courtesy The Cleveland Crane & Engineering Co.

FIG. 47. Handling Scrap Material with Overhead Tramrail Conveyor.

to the Chicago assembly plant from Dearborn. In many cases they have found it cheaper to return these cars to Dearborn empty rather than to dis-assemble these special supports, braces, and clamps that hold the parts in place. Special consideration is given to the design of parts that go to make up the finished product, having in mind their transportation from central manufacturing plants to the various assembly plants. It is no exaggeration to say that material-handling techniques have definitely in-

fluenced plant location in some industries. Mr. Ford makes extensive use of water transportation between Dearborn and Chicago during the lake transportation season.

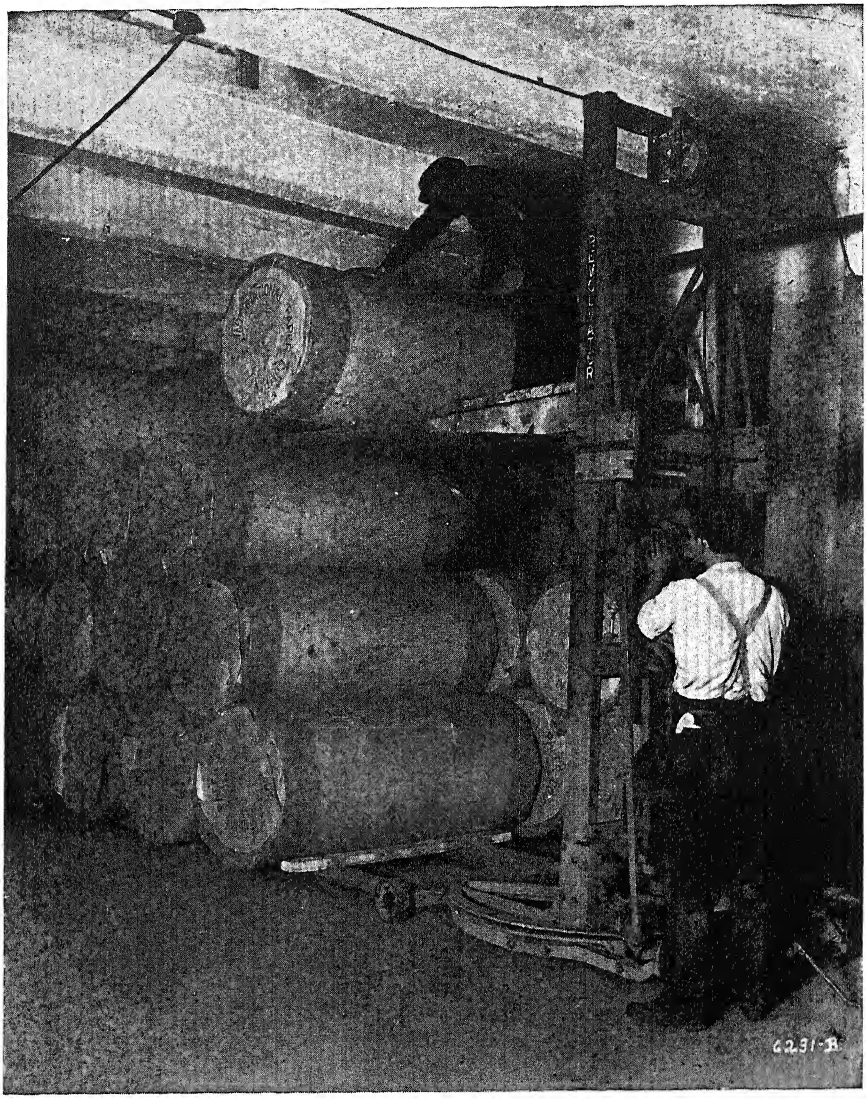


Courtesy General Motors Corporation.

FIG. 48. Tire Chute Conveyor from the Balcony to Final Assembly in one of General Motors' Automobile Assembly Plants.

Volume of production and material-handling methods. As in machine operations, the volume of production of a particular article or type is often a controlling factor in the method adopted for handling material. A conveyor may be too expensive to use for handling small volumes,

not only from the standpoint of the invested capital, but also from a labor standpoint. It is often necessary to have an operator load a con-

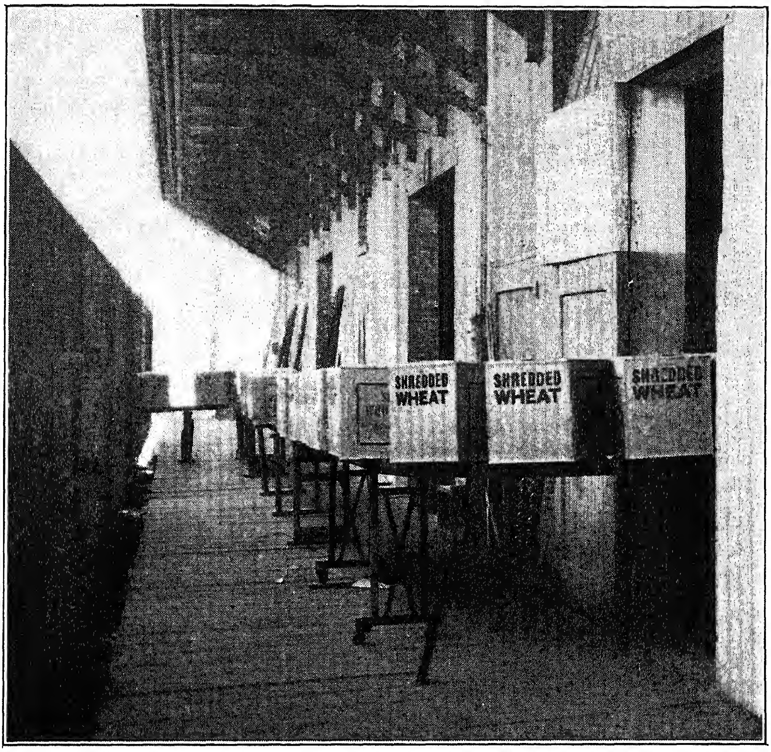


Courtesy Revolvator Company.

FIG. 49. A tiering machine saves the worker, increases productivity and conserves floor space.

veyor and another one remove the item conveyed. This situation frequently holds in spite of automatic unloading devices. The automatic

unloading device will remove the article from the conveyor, but it seldom stores it away. Some articles cannot be allowed to pile up on each other. Another situation is the case when certain items have sufficient volume for mechanical conveyors and other similar items in the same plant cannot be thus efficiently handled. For instance the Ford Motor Company in its Chicago plant dips its black fenders in paint by means of a conveyor but dips other colors, not run in sufficient quantities, by hand.



Courtesy Mathews Conveyor Company.

Fig. 50. Loading Freight Cars at the Plant of Shredded Wheat Company, Niagara Falls, N. Y.

In one plant automobile seat cushions may be assembled on a moving conveyor and in another plant owned by the same company these same cushions may be assembled on benches because of the lower volume of production.

Material handling and the worker. It is not unusual to find that a particular article can be moved as quickly or even more quickly by man power than by some mechanical means yet a mechanical method is used to reduce the physical strain on the worker. Sometimes a machine

operator gets his material and returns the finished product to a central place not because it can be done better by him than by mechanical means or by a special trucker, but as a means of breaking the monotony of his work or to reduce the fatigue of sitting in one position for too long a period. This practice is frequently followed in the sewing industry, such as making men's clothing.

CHAPTER XI

ARTIFICIAL ILLUMINATION

Modern management has recognized that effective illumination of the workplace is one of its most productive investments. The modern factory building is so designed as to make maximum use of natural illumination, but this is not sufficient for multiple-shift operations nor cloudy days. Artificial illumination has been developed to take care of these situations. Scientific research of large electrical manufacturers and the Illuminating Engineering Society, together with the accumulated experience of plant superintendents, has given us artificial industrial light to meet the requirements of most manufacturing needs.

Good lighting is necessary, not only from the production standpoint, but from the social standpoint. Since the modern industrial system forces so many members of the community to use their eyes on close work, it becomes essential, from the standpoint of community health, that industrial lighting be adequate.

Results of defective lighting. The results of the carefully controlled study of lighting conditions by the Western Electric Company, Hawthorne Plant, Chicago, showed the difficulties encountered in ascribing increased production solely to one factor; however, there is little question that defective lighting increases waste, places an unnecessary strain upon the employees, and tends to decrease productivity.[1] In a pamphlet entitled *Light Conditioning—Industry's New Power*, distributed by the Public Service Company of Northern Illinois, Table 2 is given as illustrative of the influence of improved lighting upon production.

Accidents are increased by improper lighting. "Many factors of poor illumination, such as glare, both direct from the lighting unit and reflected from the work, or dark shadows, hamper seeing and will cause after-images and excessive visual fatigue which are an important contributing cause of industrial accidents. Many accidents which are at-

[1] M. Luckiesh and Frank K. Moss, *The Science of Seeing*, D. Van Nostrand Company, New York, 1937, p. 157.

TABLE 2

EFFECTS OF ADEQUATE LIGHTING ON PRODUCTION

* Company—Operation	Old Level in Foot-candles †	New Level in Foot-candles †	Percentage of Production Increase
American Metal Works, Philadelphia, Pa., Turret Lathes	12	20	12
Decorative Lamp & Shade Co., Philadelphia, Pa., Metal Shop	3	15	18
Decorative Lamp & Shade Co., Philadelphia, Pa., Woodworking Shop	5	25	21
Detroit Piston Ring Co., Detroit, Mich., Grinding and Machine Work	1	14	26
Matell Mills, Philadelphia, Pa., Splicing	5	28	8
Philadelphia Sweater Mills, Philadelphia, Pa., Knitting	5	17	11
Realart Silk Hosiery, Philadelphia, Pa., Knitting (Night)	7	17	6
Reid Hosiery Co., Philadelphia, Pa., Knitting	6	17	6
John Sidebotham, Philadelphia, Pa., Loom	7	16	11
Timken Roller Bearing Co., Columbus, Ohio, Inspecting	5	20	13

* Data originally taken from *G-E La Salle Course on Lighting Salesmanship in the Fields of Selling, Seeing, Production*—Part 4, p. 124

† A foot-candle is that unit of illumination intensity which is equal to the direct illumination given by a standard candle when placed one foot from the object illuminated.

tributed to the individual's carelessness can actually be traced to difficulty of *seeing.*"[2]

Advantages of adequate lighting. The Illuminating Engineering Society cites the following advantages of good industrial lighting:

1. Greater accuracy of workmanship, resulting in an improved quality of product with less spoilage and rework.
2. Increased production and decreased costs.
3. Better utilization of floor space.
4. More easily maintained cleanliness and neatness in the plant.

[2] See Illuminating Engineering Society, *Recommended Practice of Industrial Lighting*, p. 15. (This pamphlet is not dated; however, it refers to studies made by the Society as late as 1937.) Also see B E Simpson, "Light and Sight—First Aid for Safety and Production," *Transactions Illuminating Society*, 23, 1928, p. 633.

5. Greater ease of seeing, especially among older, experienced employees, thus making them more efficient.
6. Less eyestrain among employees.
7. Improved morale among employees, resulting in decreased labor turnover.
8. Fewer accidents.[3]

Proper lighting throughout the department reduces the tendency to crowd machines near the windows to take advantage of natural lighting for close work. A uniform level of general lighting makes one part of the workplace practically as desirable as another, thus enabling the industrial engineer to make most effective use of the floor space.

The general character of the workplace, for instance, its cleanliness, has a direct result on the production that is secured. Good lighting has a direct effect on the cleanliness of the workplace and its maintenance in general all-round good condition. As a rule, a dark shop is also a dirty shop; a light shop is usually a clean shop. There is nothing so bad for dirt as plenty of light. Light, and especially sunlight, has a direct influence upon the destruction of various bacterial organisms, especially tubercle bacilli. Moreover, an abundance of light in a factory has an undoubted psychological effect upon the cheerfulness and well-being of the workers. This, in turn, tends to reduce labor turnover.

Requirements of artificial illumination. Artificial light must be provided as a continuous supplement to daylight in places where the latter is insufficient, to provide for lighting after dark during regular working hours in winter, for night work, and for outdoor lighting at night. The minimum time that a normal industry will use artificial light during the year is 20 per cent of the total working hours. To this must be added that use which is constant when daylight cannot reach a workplace adequately.

The illumination provided artificially should (1) be of sufficient intensity for the particular operation being performed, (2) be diffused and not glaring, either directly or through reflection, (3) be uniform and not permit marked shadows. Absence of glare usually results in reduction or elimination of marked shadows. Uniformity of lighting desired depends somewhat upon its application, and the diffusing of the light source is usually for the purpose of eliminating glare as far as possible.

Sufficiency of illumination. Sufficiency of illumination can be measured in terms of foot-candles by simple devices which record the extent of illumination at any given point. (See Fig. 52.) The output of electric light bulbs is expressed in terms of lumens. One lumen will light a surface of one square foot to an average intensity of one foot-

[3] *Op. cit.*, Illuminating Engineering Society, p. 7.

candle. The number of lumens required to light a surface to any given illumination is the area of the surface in square feet multiplied by the average foot-candles of illumination desired. The following table gives the number of lumens produced by standard incandescent lamps.

TABLE 3

LUMEN OUTPUT OF INCANDESCENT LAMPS *

Wattage	Voltage	Lumen Output	Lumens per Watt
25	110, 115, 120	258	10 0
40		440	11 0
60		762	12 7
100		1530	15 3
200		3400	17 0
500		9800	19 6

* Source of data· *Handbook of Interior Design*, Industry Committee on Interior Wiring Design, 1937, p 68.

An examination of the table above discloses the fact that the lamps of higher wattage are more efficient than the lower ones. In this connection it is also well to note that special bulb shapes or finishes lower the efficiency of lamps. For instance, a 40-watt tubular lamp has a 10 per cent lower output than a standard lamp.[4]

The amount of illumination intensity required for any given operation is a matter of judgment. In recent years the amount considered to be sufficient has increased markedly. Whereas a few years ago 4 to 8 foot-candles were deemed sufficient where medium discrimination of detail was needed, today the generally accepted amount of light is 10 to 20 foot-candles, with the tendency toward the upper limit rather than the lower. In considering the effect on the eyes of insufficient illumination, it is interesting to observe that the intensity of light on a clear summer day out of doors is from 1000 foot-candles in the shade to many times this amount where there is no protection. Although intensities of 1000 foot-candles are impractical from an electrical and cost standpoint with artificial lighting, fine work requiring much concentration needs 50 to 100 foot-candles to be carried on constantly without undue strain. In general the following table will serve as a guide to the illumination required for various tasks: [5]

[4] *Handbook of Interior Design, op. cit.*, p. 39.

[5] For detailed information on industrial occupations, see *Handbook of Interior Wiring, op. cit.*, pp 48-51; for office occupations, see W. C. Brown and Dean M. Warren, *Lighting for Seeing in the Office*, General Electric Company, Cleveland, 1936, pp. 12-13.

TABLE 4

LIGHT REQUIREMENTS FOR VARIOUS OCCUPATIONS

	Foot-candles
WHERE DISCRIMINATION OF DETAIL IS NOT ESSENTIAL.	2–5
Handling material of a coarse nature; grinding clay products; rough sorting; coal and ash handling; foundry charging.	
WHERE SLIGHT DISCRIMINATION OF DETAIL IS ESSENTIAL	5–10
Rough machining; rough assembling; rough bench work; rough forging; grain milling.	
WHERE MODERATE DISCRIMINATION OF DETAIL IS ESSENTIAL.	10–20
Medium bench and machine work; fine molding and core making; newspaper printing.	
WHERE CLOSE DISCRIMINATION OF DETAIL IS ESSENTIAL.	20–30
Tool making; weaving; stitching and trimming.	
WHERE VERY CLOSE DISCRIMINATION OF DETAIL IS ESSENTIAL.	30–50
Electrotyping; glass cutting; polishing and inspecting; drafting.	
WHERE DISCRIMINATION OF MINUTE DETAIL IS ESSENTIAL	50–100
Fine bench and machine work; fine inspecting; typesetting; engraving.	

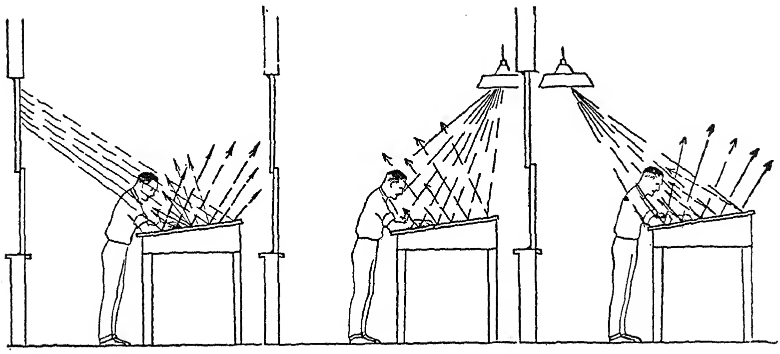
Work on light and dark materials fall into different ranges of intensity. Dark and rough surfaces absorb much more and reflect much less light than do smooth, light ones. Similarly, the amount of light required will be affected by the machinery that is used. Machinery that is painted black will absorb a great amount of light. Machinery that is painted gray will not cause undue reflection of light where it is not wanted, and at the same time will not absorb nearly so much light.

While the quantity of light is very important, it should not be forgotten that this is only one factor in scientific illumination. Other factors to be considered are the distribution and quality of the light, contrasts, shadows, color, and glare.

Glare and reflectors. Glare is of two kinds, glare from the source of light, and glare of reflection from bright surfaces. In either case it is light out of place. Figure 51 indicates the manner in which the proper placing of light sources and proper type of reflector will eliminate the glare of reflection. Glare arises from improper diffusion, from the source of the light being intrinsically too brilliant (more than about 2½ candles per square inch), and from the angle between the light, the work, and the eye being too small (less than about 30 degrees).

The source of light is but raw material to work with in the provision of proper light and the elimination of glare. It is the reflector that turns this raw material into adequate illumination. Indirect and semi-indirect reflectors are not as a rule suited to industrial use except in the offices. In general industrial reflectors are of three types or variations of these types; namely, (1) the RLM (Reflector and Lamp Manufacturer), (Fig. 53), (2) the Glassteel Diffuser, (Fig. 54), and (3) the High Mount-

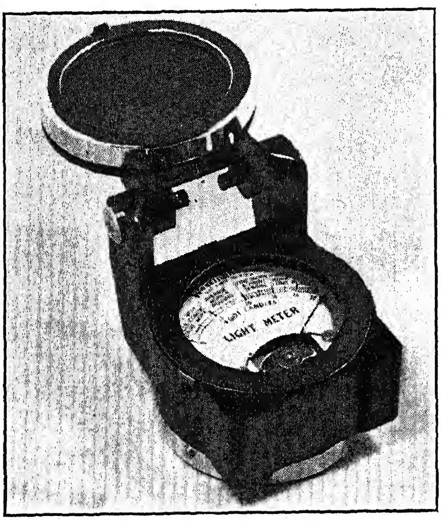
ing Reflector, designed for use in narrow interiors such as craneways to be mounted at least 20 feet above the floor.



Courtesy Edison Lamp Works.

FIG. 51. Effect of Changes in Placing Light Outlets with Proper Reflectors.

Types of electric lamps. The most popular type of electric light bulb is the tungsten filament lamp which, when used in proper sizes and with appropriate reflectors, will give adequate illumination for most purposes. Lamps with certain inert gases are generally more efficient than those in which the filament is enclosed by a vacuum. Daylight lamps and mercury-vapor lamps are also used for special purposes. In purchasing lamps, the cost per lumen produced over the efficient life of the bulb should be the governing consideration in determining the particular make to be bought.

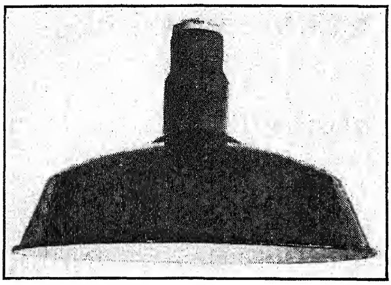


Courtesy Westinghouse Electric & Manufacturing Co.

FIG. 52. A Foot-candle Light Meter. (The sensitive cell is in the top which folds down when not in use.)

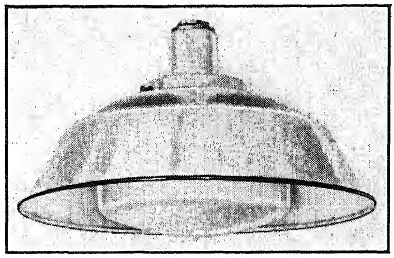
Daylight bulbs are used where accurate color determination is needed. These bulbs are made of a special blue-green glass that absorbs a part of the reddish rays which are in excess in the usual tungsten filament lamp. Since the glass in the daylight bulb absorbs approximately one-third of the total light emitted by the filament, for efficiency reasons they should not be used except when absolutely necessary.

Special reflectors must be used under unusual conditions. Deep bowl reflectors must be used where a deep shielding angle is required to



Courtesy Westinghouse Electric & Manufacturing Co.

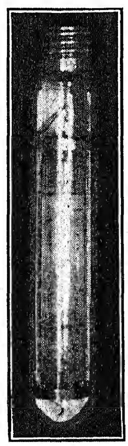
FIG. 53. R. L. M. Reflector.



Courtesy Westinghouse Electric & Manufacturing Co.

FIG. 54. Glassteel Diffuser.

eliminate glare from the lamp filament, for instance where the mounting height is low, less than 8 feet above the floor. For all elevations up to 20 feet it is best to use a white bowl bulb; above that clear lamps may be used.



Courtesy Westinghouse Electric & Manufacturing Co.

FIG. 55. A Modern Mercury-vapor Lamp.

Uniform diffusion. Uniform diffusion of the light ranks with sufficient intensity as one of the prime essentials of proper lighting. The measure of effectiveness of a lighting system is not the brilliance of the source, nor of the object illuminated; but the ability of the worker to distinguish clearly and differentiate easily without eye-strain. Extreme brilliance improperly diffused only tends to tire the eyes and confuse the vision. The essentials in this respect are the avoidance of irritating brilliancy or obscurity, the confusing shadows of which are usually a result of the former condition. All portions of the room must be illuminated; there cannot be any dark spots which the eye will see and contrast with the brilliant spots where light falls.

Adequate diffusion makes possible ease of discernment of any object, or portion of an object in any plane, horizontal or vertical. Although large areas of dark shadow must be eliminated, entirely shadowless illumination is not to be desired. Shadowless objects are flat and not normal to the eye.

Shadows are influenced by the spacing and the hanging height of the lighting units. A broad, spreading cone of light, such as is produced by the RLM reflector, allows a lower mounting height than reflectors

which concentrate light within narrow cones. The Glassteel Diffuser encloses the lamp in a white diffusing glass globe, and the porcelain enameled steel reflector has several slots through which some light is directed to the ceiling, thereby offering less contrast between the ceiling and the workplace.

Mercury-vapor lamps. For many years in operations where clear definition of surface is the outstanding requirement, mercury-vapor tube lamps have been used.[6] Objections have been the high cost of operation compared to the tungsten-filament lamp, the size of the tube (50 inches long), and the ghastly appearance given to workers under these lights. Special transformers or reactors must be used in connection with the mercury-vapor lamp because of the fluctuation in voltage. A relatively new high intensity mercury-vapor lamp has been developed that utilizes the standard screw base and is much shorter in length (see Fig. 55). The full extent of use of this new lamp has not yet been developed, but it bids fair to be an extremely valuable addition to industrial lighting equipment for operations such as foundries, spinning mills, small assembly work, composing rooms, and other places where close definition is needed.

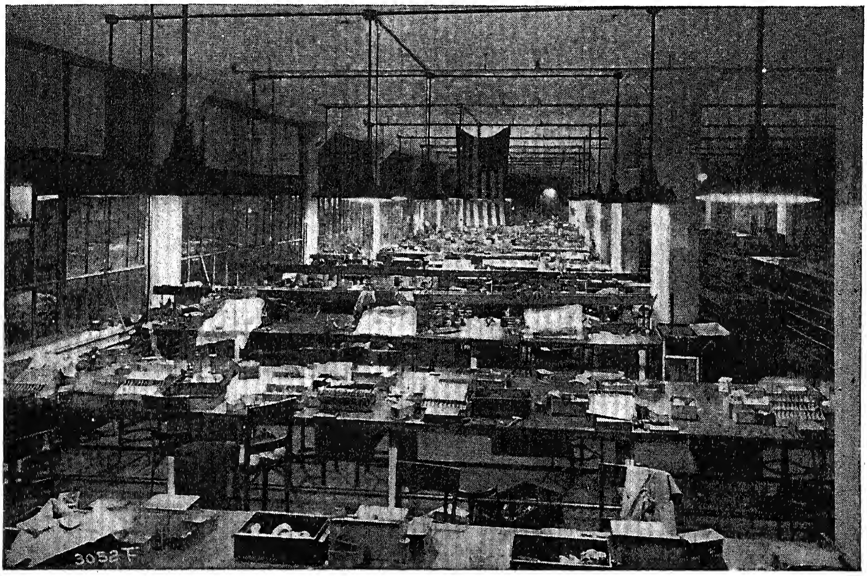
Installations have been made combining the new mercury-vapor lamps with the ordinary filament lamps on a basis of equal lumen output from both. The result approximates the natural appearance of colors; however, there is still some color emphasis, particularly the yellows.

Fluorescent lamps. The Fluorescent Mazda Lamp has created much interest in lighting circles. This lamp is an extension of the mercury-vapor principle or other types of "electric discharge" sources. Approximately only half of the lamp wattage is radiated or accompanies the lumens. This characteristic of fluorescent lamps makes them ideal sources for the production of high levels of illumination at relatively low temperatures and is especially desirable for certain installations such as show cases in meat markets. This light can closely approximate daylight and also be so constructed as to give many different colors.

Methods of arranging artificial lighting sources. In installing lighting systems there are several methods of arrangement which may be employed. They are individually suited to particular conditions, but combinations of them are often made. The methods employed are (1) general lighting, (2) group lighting, and (3) local lighting. The most frequent combination is that of general and local lighting.

[6] The mercury-vapor lamp emits fewer wave lengths of the visible spectrum than ordinary filament lamps. The eyes need not continually adjust to obtain the proper focus, but confine their efforts to focusing on the reduced number of wave lengths. This results in greater sharpness of vision and less fatigue; hence the clearer definition.

With the growth in lighting research, equipment has been provided that makes general illumination the method most used. Comparatively large units are placed near the ceiling, giving an illumination of approximately equal intensity throughout the whole workroom. It is especially suited to miscellaneous work where a general distribution of light is more necessary than a local centralization of light in special places. An example of such conditions is found in Fig 56. General lighting, properly spaced, gives an even diffusion of light. Illumination up to 50 foot-candles can usually be satisfactorily obtained from a general



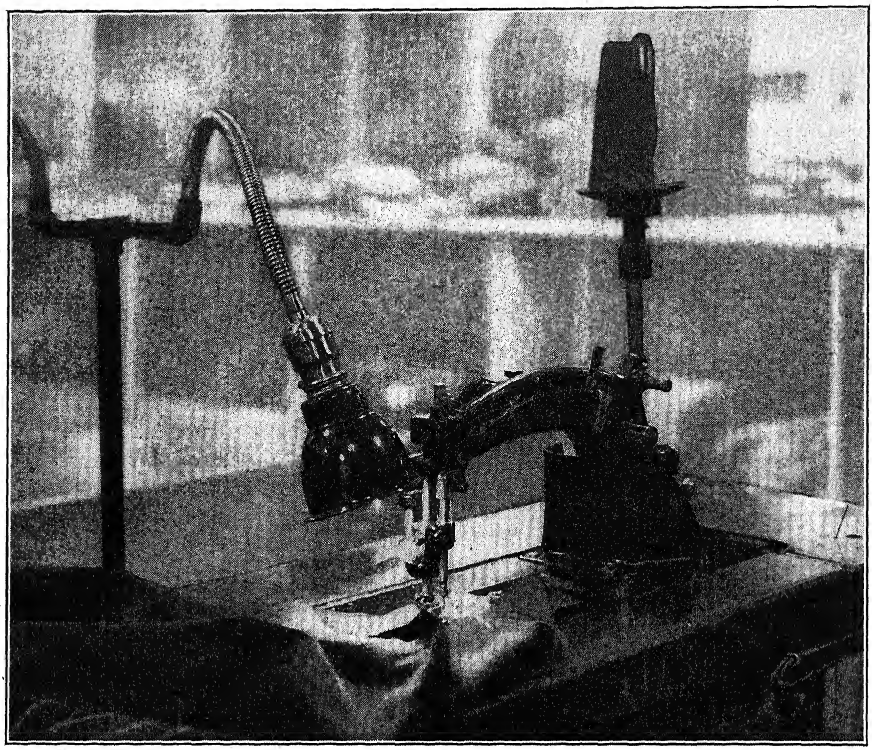
Courtesy National Lamp Works.

FIG. 56. General Lighting. Assembling small parts for adding machines—200-Watt Mazda C Lamps, 9½ feet above floor. The sharp shadows suggest the possibility of improvement through the use of bowl-enameled lamps.

lighting arrangement. For tasks requiring more than 50 foot-candles it is often more economical to supplement the general lighting with local lighting. Where 20 foot-candle general lighting is sufficient for most of the work in a workroom, but a few operations require more, the additional light can more economically be provided also by local lighting.

Group lighting, or, as it is often called, localized general lighting, consists in lighting a particular group of machines, or particular area, by units which are so placed with reference to the work as to illuminate it from the best direction. This type of lighting is particularly suitable for large rooms with many machines of the same type, performing such operations as spinning, weaving, buffing, etc.

Local lighting consists of the illumination of a single machine or portion of a machine with light which is specifically directed to the point at which illumination is most needed. Such lighting is used on work benches, lathes, sewing machines, or any class of work where a light may be needed from a nearly horizontal direction, or where a high intensity of illumination is required over a small area. Drop-cords were formerly the standard method of getting local lighting to the desired point, and



Courtesy National Lamp Works.

FIG. 57. Effective Local Illumination.

have persisted in some plants until now. Fixtures such as that illustrated in Fig. 57 are now the approved method of providing local illumination.

It is with local illumination that the greatest care must be taken to guard against glare from reflection, because the source of light is so close to the machine and the material being worked upon. Local lighting can never be used alone, but must be combined with general or group illumination. In the illustration, a 15-watt lamp is used for the local unit, and this gives an illumination intensity of 35 to 40 foot-candles at

the needle, but this is supplemented by general lighting which gives an illumination of 8 foot-candles in the room.

Maintenance of lighting installations. A consideration of continuing importance in lighting installations is maintenance. It makes no difference how effective the system may be when first installed; if it is not kept up to the standard set in the beginning, it will be of no enduring value. A few weeks' neglect under adverse operating conditions may cause the effectiveness of the system to drop below 50 per cent of normal. The maintenance of the lighting system should include a systematic plan for keeping the lamps and reflectors in a clean and otherwise suitable state. When lamps deteriorate so that their lumen output is markedly below standard, they should be replaced immediately. Proper lighting maintenance includes painting of walls and ceilings, cleaning of lamps and reflectors, and changing of bulbs when their lumen output drops markedly below standard. Proper light maintenance means more light for the same operating expense. To maintain proper lighting requires accurate knowledge of the lumens at given points at regular intervals. This information may be secured by the use of the foot-candle meter. (See Fig. 52.) There is a general tendency to continue lamps in service far past the point where the installation of new lamps would be profitable. The maintenance of the lighting system should be definitely placed in the hands of one member of the organization. The size and the structure of the organization will largely determine just where this responsibility should be placed.

CHAPTER XII

INDUSTRIAL AIR CONDITIONING

The importance of air conditioning in production has been well known for many years. The tobacco grower would not attempt to strip his tobacco when the air was dry because of the excess breaking of the leaves. It was early discovered that the manufacture of cotton thread was simplified when the humidity of the air was fairly high. In spite of the recognition of the influence of air conditioning upon certain processes, it remained for the twentieth century to develop methods of air conditioning on a relatively large scale and to expand its use to include not only the processing function but human comfort and welfare. The first large-scale attempt to control the temperature of air as a matter of human comfort was made in the theatres where the costs could be spread over a large number of persons.

Air conditioning in its broader sense is the control of the physical or chemical qualities of the air for a specific purpose. It includes the following factors taken alone or in any combination: (1) temperature, (2) humidity, (3) foreign substances, and (4) air flow.

Objectives in air conditioning. Air conditioning is usually undertaken to influence favorably the materials and product, the welfare and comfort of employees and customers, and the machinery, equipment, and manufacturing process. If these three major classifications are expanded, air conditioning may be said to seek to influence favorably materials, men, and manufacturing as follows:

1. Materials.

a. To decrease deterioration such as meats, fruits, vegetables, and certain oils, fats, and chemicals.

b. To increase workability, such as tobacco, textiles, and certain plastics.

c. To improve the quality of the products.

2. Employees and customers.

a. To protect the health—remove poisonous and obnoxious gases and foreign particles such as silica dust, lint, soot, and bacteria.

b. To improve physical comfort by regulating the temperature and humidity and by reducing distracting noises resulting in a favorable attitude or higher morale.

c. To increase the productivity of the worker without increasing the fatigue or strain, thus reducing unit costs.

3. Equipment and processes.

a. To meet the requirements of certain equipment that is sensitive to temperature changes, moisture, and foreign substances in the air.

b. To reduce the maintenance cost of equipment.

c. To meet the requirements of certain processes.

The outline above is in sufficient detail for the influence of the air condition upon materials. It would be well to consider further the human aspect and the influence of air conditioning upon equipment and processes.

Air conditioning and the individual. Man's reactions to the condition of the atmosphere in which he operates is both a psychological and a physiological one, each somewhat influencing the other.[1] Odors in a room may react unfavorably upon the employee even though there is no detrimental physical action. The addition of another odor which merely drowns out the first odor but does not remove its cause often has the same effect upon the worker as removing the odor.

The feeling of comfortableness of an individual in still air is greatly influenced by his activity. The average-sized man seated at rest in still air of approximately 70° F with 50% relative humidity, generates about 400 BTU's per hour. When this same man under similar conditions engages in light, moderately heavy, and heavy work the BTU's generated per hour rise respectively to approximately 600, 800, and 1000. This heat is dissipated through direct contact with the air as "sensible heat" or through evaporation of perspiration from the skin or the evaporation from the respiratory tract, "latent heat."

The most important factors in poor industrial air conditions are improper temperature and improper humidity, or a combination of these two Approximately 3000 cubic feet of air per person per hour, of the right temperature and humidity, should be provided, and the air can be changed from three to five times an hour to give this amount of air per person without any feeling of draft in the room. The proper temperature of air in a factory workroom depends upon the operation and upon the humidity. If the operation be one involving hard manual labor, it may be that in the winter months a temperature of 55 degrees will be sufficient. The ordinary factory workroom can be held at 65 degrees and be comfortable if the humidity is correct. In the usual type of steam-heating system that is likely to be found in a factory, air which is 40 degrees in temperature on the outside is brought in and heated

[1] For an excellent discussion of this subject, see American Management Association, *Production Series No. 119*, "Air Conditioning in Industry," by F. C. Houghten, Director of the Research Laboratory, American Society of Heating and Ventilating Engineers.

up to 70 degrees. Naturally, this dries the air and makes it absorb moisture from anything, particularly from the bodies of the workers in the room. This gives rise to the feeling of discomfort and irritation which is frequently found in factory workrooms during the winter months. Air at 75 degrees temperature and 20 per cent relative humidity does not feel as warm as air at 68 degrees temperature and 50 per cent relative humidity, or 65 degrees temperature and 65 per cent relative humidity. Of course humidity cannot be continually increased Much of the discomfort of summer temperatures is due to the high humidity, and 70 per cent humidity is probably the maximum to which any air should be allowed to come for normal working conditions.

The following table gives a range of effective temperatures for individuals engaged in sedentary or light muscular activities. It should be kept in mind that there are individual differences within the same group as well as group differences between areas. For instance, the people of the Gulf Coastal Region will demand a comfort zone several degrees higher than the people of Milwaukee.[2]

TABLE 5

DESIRABLE INSIDE CONDITIONS IN SUMMER CORRESPONDING TO OUTSIDE TEMPERATURES * (OCCUPANCY 40 MINUTES)

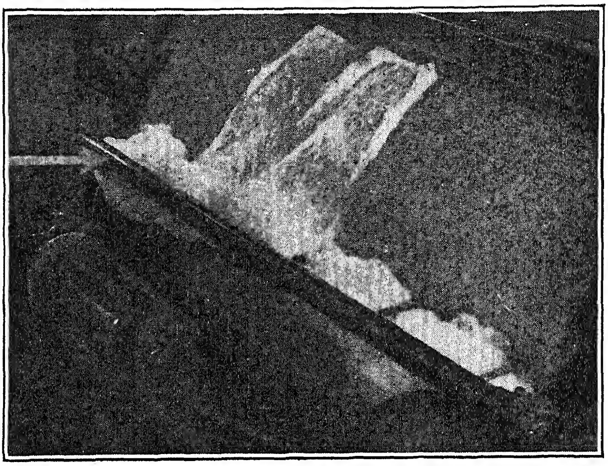
Outside Dry-Bulb, Deg. F.	Inside Air Conditions			
	Effective Temperature	Dry-Bulb, Deg. F.	Wet-Bulb, Deg. F.	Relative Humidity, Per Cent
100	75 75	83 80	66 70	40 60
95	74 74	82 78	64 70	36 68
90	73 73	81 78	63 67	36 56
85	72 72	80 77	61 66	32 56
80	71 71	78 75	61 66	36 61

* Copyright, American Society of Heating and Ventilating Engineers Abstracted by Permission from Table 2, Chapter 3, *Heating, Ventilating, Air Conditioning Guide*, 1939, p 66.

For persons engaged in active, medium or heavy muscular work the table above is too high. The entire field of accurate control of air conditions is highly technical. Management should consult specialists in this field before spending large sums of money for an installation.

[2] A S H V.E. Heating, Ventilating, Air Conditioning Guide, Vol. 17, p. 66, 1939.

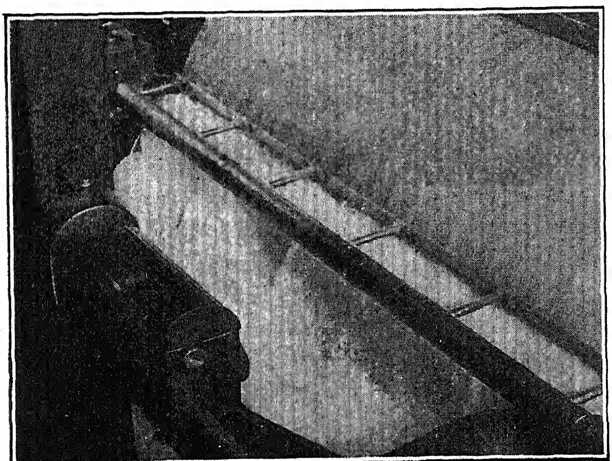
The individual is often not so keenly sensitive to foreign substances in the air as he is to changes in temperature and humidity; yet these substances often are immeasurably more detrimental to his health. Certain occupational diseases arise from floating particles in the air. Silica is one of the most dangerous dusts.



Courtesy Parks-Cramer Company.

FIG. 58.—Difficulties in Starting the Card in a Dry Atmosphere. Static electricity causes cotton to cling to the doffer and the doffer comb.

Individual productivity is increased and fatigue is reduced by favorable working conditions. Temperatures and relative humidity are vital factors in comfortable working conditions. The retarding effects of unfavorable working conditions depend somewhat upon the characteristics of the workers and the nature of the work. It is not uncommon to find "white collar" workers handicapped as much if not more than manual workers by high temperatures. This may especially be true if the higher temperatures create unfavorable conditions on their work such as perspiration interfering with drafting.

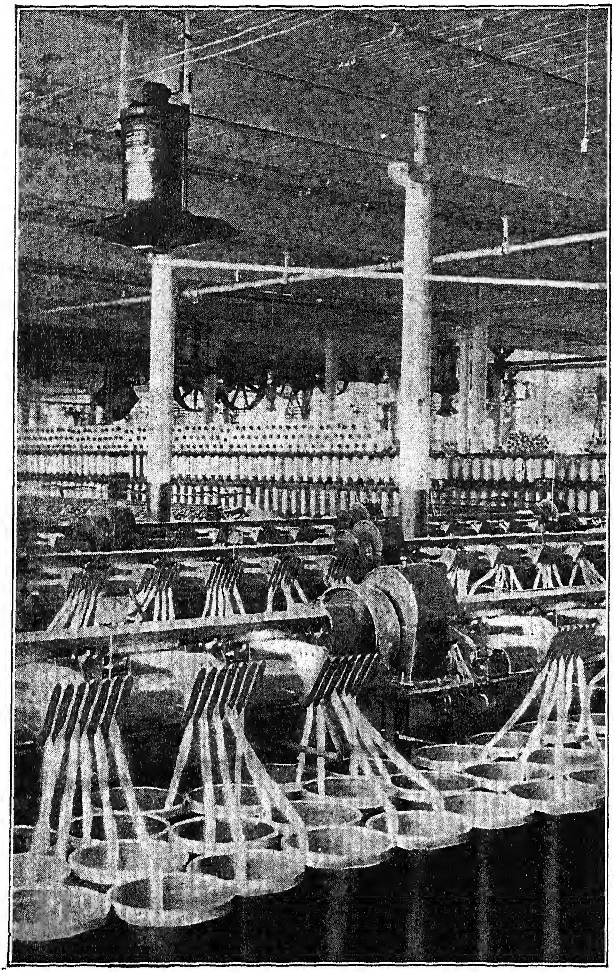


Courtesy Parks-Cramer Company.

FIG. 59.—Humidity Sufficient to Allay Static Electricity Prevents any Tendency of the Cotton to Cling to the Doffer and Comb.

The effects of air conditioning on equipment and processing. Certain processes are markedly influenced by the temperature and humidity of

the air. A few of the industries having such processes are: the spinning and weaving, baking, candy manufacturing, flour milling, precision tool manufacturing of certain types, food storage, certain types of woodworking, the blast furnace, the tobacco industry, and the rubber industry.



Courtesy Parks-Cramer Company.

FIG. 60. Cotton Drawing, Utilizing Individual, Spray Humidifiers.

In textile mills, it is essential that moist air conditions be present. (See Figs. 58, 59, and 60.) This was the original cause of the textile mills of New England locating near the foggy seacoast. If there is too little humidity in the atmosphere, the yarn becomes very dry in weaving, and snaps, thus necessitating frequent stoppage of the loom and knotting of broken threads. If the humidity is too great it affects the texture of the yarn, causing it to swell unevenly and making a poor grade of goods.

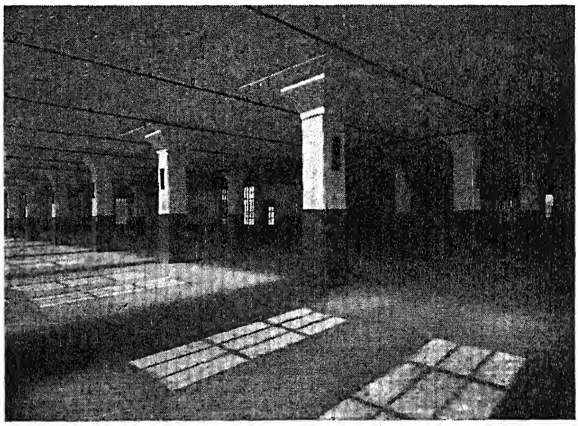
With the introduction of modern air conditioning, the textile industry can create its own climatic condition as far as manufacturing requirements are concerned. This fact has greatly influenced the migration of textile mills to the South.

Cabinet-making plants, where veneering is used, also have less trouble with their raw material when it is worked up under proper temperature and humidity conditions. Not only is air conditioning a valuable aid to

the working of wood but the application of the techniques of air conditioning has greatly hastened the drying of lumber. It is no longer necessary to stack it for long periods in the open air to allow it to "season." Kiln drying has largely replaced the air-drying process.

The Woodward Iron Company of Alabama has applied the principle of air conditioning to control the moisture content of the air used in their blast furnace. The air is then preheated before being forced under pressure into the furnace. This is a further step in standardizing their process of manufacture.

Design of the building and air conditioning. The desire to take advantage of modern techniques in air conditioning has exerted a profound influence upon building design. Where a central system is planned, the air ducts are built into the walls and columns of the building as integral parts of the structure itself, thus avoiding one of the objections to this system when installed after the building is constructed, when it is almost a necessity to place the air ducts overhead in the rooms (see Figs. 61 and 69).



Courtesy American Blower Co.

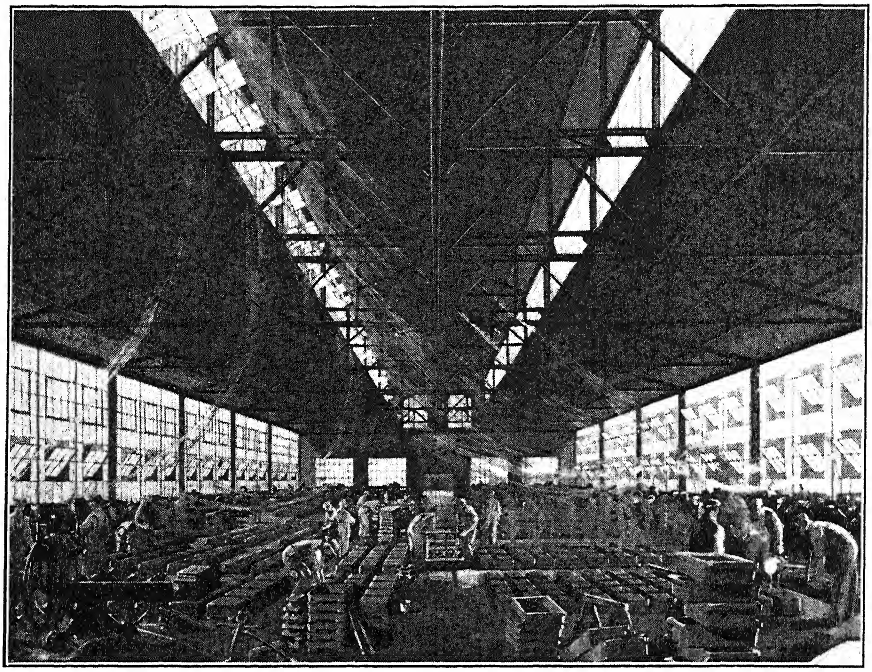
FIG. 61. Distributing Ducts for Heating System in Columns on Machine Shop Floor, Crown Cork & Seal Co., Baltimore, Md.

Building construction also takes into consideration the requirements of natural ventilation. As yet, natural ventilation is relied upon in most cases to carry off heat from the machines and to provide the required fresh air for the workers. Natural ventilation, in spite of the rapid strides made by controlled air conditioning, is still widely used in removing fumes and heat from furnaces and foundries. (See Fig. 62.) There is usually a prevailing wind in each locality. The greatest natural flow of air into and out of a building is secured when the prevailing wind blows at right angles to the wall having the greatest open window area.

The windward side of monitor roofs should be kept closed and the leeward side opened to get maximum natural ventilation. The wind will under these conditions create a suction, drawing the air from inside the building and out the open windows in the monitor. (See Fig. 62.) The size of the monitor openings and their height above the inlet openings are the major factors in determining the extent of the air flow.

Saw-tooth roofs are not well adapted to situations presenting severe ventilation problems, as the fact that they usually face the north may make ventilation difficult should the prevailing wind be either from the east or west. If the prevailing wind be from the south (an unusual condition) the saw-tooth roof is satisfactory.

Equipment Used in Air Conditioning. Heating. The oldest attempts at air conditioning consisted of raising the temperature when the outside



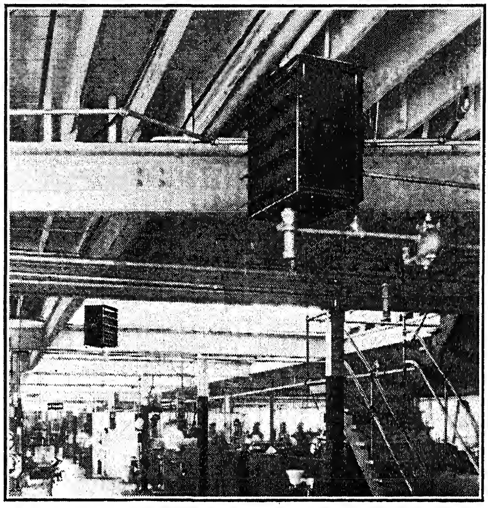
Courtesy Detroit Steel Products Co.

FIG. 62. Good Ventilation in a Foundry. (Monitor roof, lee windows open with windward side windows closed. Side wall windows open.)

air is too cold. Steam pipes along the walls are still found in many of the older plants. These are wasteful of floor space, since it is difficult to place machines directly adjacent to the heating coils. Such installations always resulted in non-uniform temperatures, the windward side of the building being cold and the windows creating certain temperature problems because of the seepage of air usually occurring around them. The newer factory construction, involving as it does huge areas devoted to window space, has intensified the difficulties of heating by the old methods in factories, since the large majority of the heat from radiators near the

windows is likely to be expended in keeping outside cold air from forcing its way in. Under such heating conditions humidity control is at best only a makeshift.

The long steam pipes along the walls gave way to the more efficient radiators, many of which were installed along the walls, as well as other places in the room for more effective heating. This development was followed by a type of central heating system consisting of forcing air over heated coils and distributing the heated air to the work places. This system draws a fresh air supply into the building and propels it through the building by means of ducts, the outlets of which are properly spaced and so constructed as to prevent the seepage of cold air through the window surfaces. The disadvantage of this system is the presence of the large ducts usually overhead. They obstruct overhead lighting and at times are in the way of overhead cranes and conveyors. This system is admirably adapted to filtering the air before distributing it to the workrooms. It also lends itself to humidity control by adding the proper amount of moisture at a central control point.



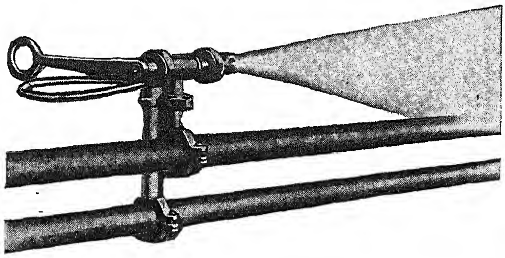
Courtesy American Blower Corporation.

Fig. 63. Unit Heaters Using Steam for the Heating Medium.

Many plants which have installed systems of this type have found it very difficult to prevail upon employees to keep the windows closed. In fact, some plants have had to go so far as to seal their windows shut, and even then they frequently found in the summer time that employees had removed these seals, although theoretically the air conditions within the building were much more satisfactory than those on the outside. Some manufacturers have solved this problem by constructing windowless plants.

All of these systems discussed above are now found in various plants; however, the present tendency is toward the use of unit heaters placed where the heat can be most effectively distributed. These unit heaters (see Fig. 63) are constructed of coils, heated by steam, hot water, elec-

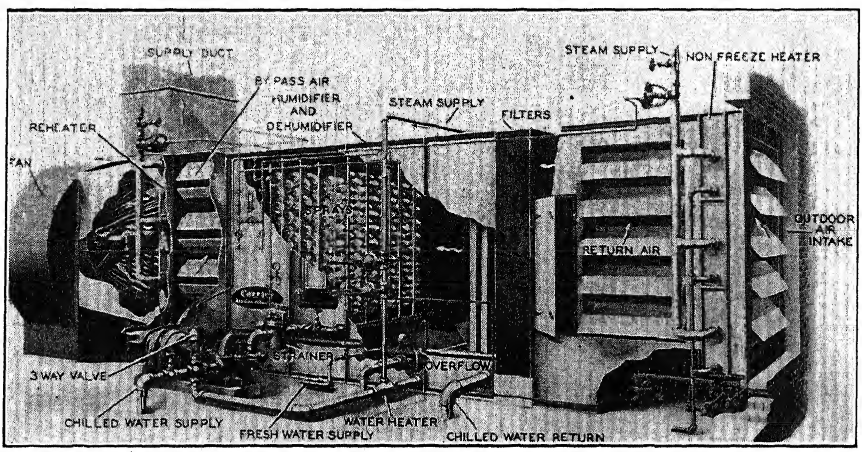
tricity, or gas, through which air is forced. The air may be brought in from the outside, from a central conditioning station, or it may be recirculated within the room. These units may be equipped with air filters and some of them, for special installations, may be equipped to control humidity. These heaters have the advantage of being located so as to circulate the air and thus avoid air stratification, particularly near the ceiling or near the floor.



Courtesy Parks-Cramer Company.

FIG. 64. An Atomizer Humidifier. It relies on compressed air as the atomizing and distributing agency.

Reduction of temperature and humidity control. Admitting outside air in winter is the oldest type of reducing the temperature within a building. It is still used extensively. An alternative method is to reduce

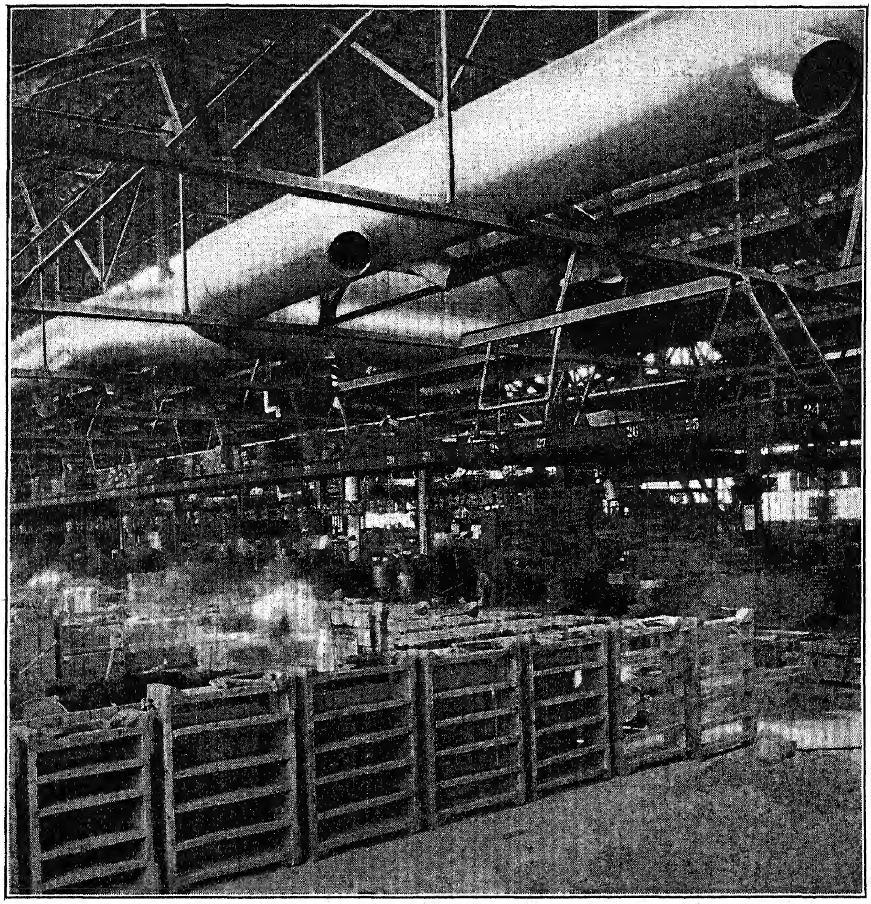


Courtesy The Carrier Company.

FIG. 65. Carrier Central Station Air-conditioning System.

the amount of heat being fed to the radiators or heating units. Admitting air from the outside during cold weather, either directly through the windows or through central heating stations, causes a drop in the relative humidity when this air is heated. Under such conditions satisfactory humidity can be obtained only by adding moisture to the air unless

there is considerable moisture given off from the manufacturing process; in this event, in the summer moisture will be required to be removed or the air changed rapidly. Moisture in radiator-heated rooms may be added by placing humidifying saddles on the radiators. These are not entirely satisfactory. The central heating system using ducts to distribute



Courtesy American Blower Corporation.

Fig. 66. Air-conditioning System showing Ducts supplying Cool Air to a Foundry.

the air to the workrooms may have connected with it a moisture control unit. Figure 65 illustrates a modern central heating and air-conditioning unit. This unit is a year-round unit and will heat or cool, humidify or dehumidify, clean, and circulate the air. All of the air may be taken from the outside or only a portion of it, depending upon conditions. It is usually more economical to recirculate a portion of the air.

Where there is not a central system but unit heating is used, it is possible to install unit air filters, humidifiers, and cooling units, either separately or as an integral part of the unit heaters. If it is not desired to condition all of the air within a plant, the unit air conditioners are cheaper.

The separate humidifier (Figs. 59 and 64), which is located in the rooms of many textile mills, is still solving the problems of a large number of such plants satisfactorily. However, air-conditioning systems such as those just described can be of benefit to such textile plants, particularly in the summer time, because, through them, the humidity can either be increased or reduced at any given time. In summer time proper processing demands a decrease in the humidity rather than an increase. (See Figs. 68 and 69.) The problem of the bakery is solved by establishing a proof chamber with a temperature of approximately 120 degrees and correct humidity, which is easily controlled. This chamber can be separated from the workrooms where the workers are found.

Glass factories and other plants where workers are likely to suffer from intense heat can have the air conditions bettered by means of a ventilating system which includes cold-air ducts, such as those illustrated in Fig. 66.

Removal of dust from materials worked in process may be made certain by a dust-collecting system, such as that illustrated in Fig. 67.

Removal of foreign substances from the air. Foreign matter may be removed from the air wholly or in part by the following methods:

1. Washing—forcing the air through a spray of water. This method will remove certain large particles and some gasses that are soluble in water.

2. Mechanical filtration—passing the air through the filters which collect particles above a certain size.

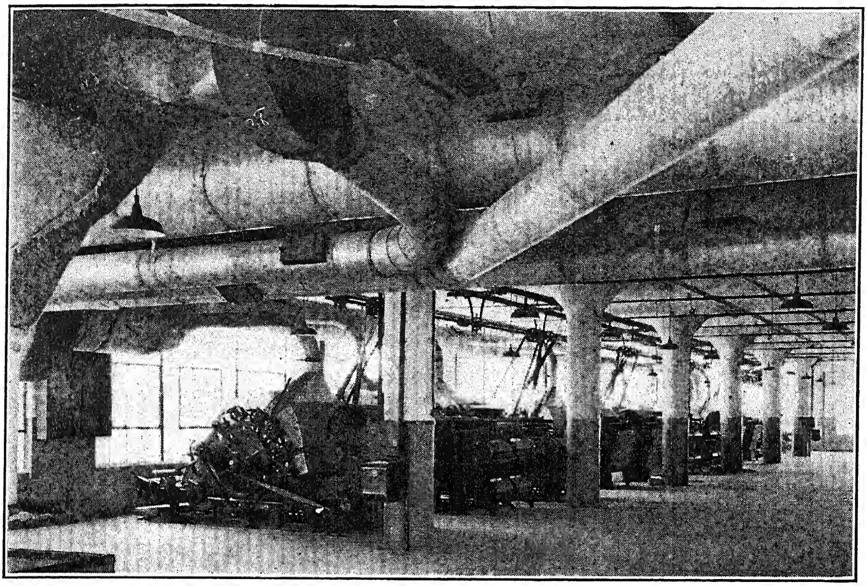
3. Electrostatic precipitation.

Washing air has the advantage of adding humidity and lowering the temperature. Under certain conditions it may be necessary to dehumidify to get the proper humidity. For certain conditions this system is entirely satisfactory.

Mechanical filters are all classified under the following headings: throwaways, those that are used until they become partially clogged, and are then discarded; permanent, those that may be removed and cleaned; replacement fabric type, those that may be removed and have new fabric inserted; and the continuous oil type (automatic).

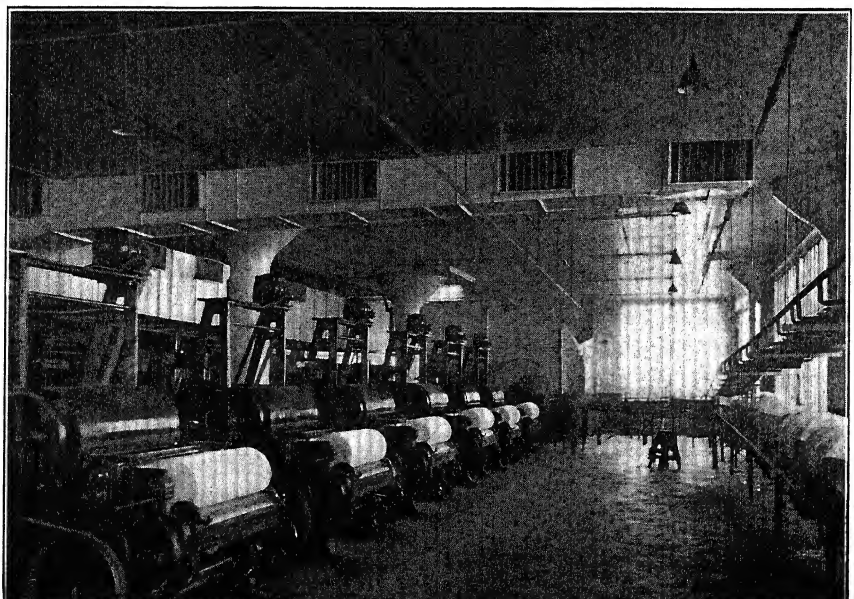
Electrostatic precipitation has been successfully used for years in smoke stacks of boilers, smelters, cement mills, etc.[3] For the first time

[3] See A.M.A. *Production Series No.* 119, "New Developments in Solving Industry's Problems of Dust and Air Pollution," by George F. Begoon.



Courtesy The Carrier Company.

Fig. 67. Dust Collection in Asbestos Carding.



Courtesy The Carrier Company.

Fig. 68. Air Conditioning in the Carding Room, Jackson Mills, Nashua, N. H. Central system.

(1939) this same principle has been adapted to cleaning air for use in the workplace, hospitals, hotels, etc. The Westinghouse Electric and Manufacturing Company has developed an air-cleaning mechanism known as the Precipitron which bids fair to clean air for commercial

Courtesy The Carrier Company.

FIG. 69. Process Air Conditioning in Roving Operation, Jackson Mills of Nashua Manufacturing Co., Nashua, N. H. (Central system.)

purposes to a degree far in excess of anything that has yet been available. The Precipitron's initial cost is considerably greater than mechanical filters and washing systems. As yet it has not had sufficiently wide use to know just what industry will do with it.

CHAPTER XIII

FACTORY POWER

The management of an industrial enterprise is concerned with three primary requisites relative to factory power, namely, (1) that there is adequate power at the machines to do the full amount of work scheduled for the factory; (2) that this power is secured in the most economical manner consistent with the long-run company policy; and (3) that the service is free from interruptions. The subject of factory power is so large that it would be impossible to give it adequate technical treatment in this book, even though it properly had a place therein. It is necessary only to outline the general principles governing the subject so that the manager may consider intelligently the engineer's report. There are certain phases of this problem, however, that can be passed upon only by the management, such as the decision to buy central station power for all manufacturing requirements or only peak requirements, to scrap an installation now in use and purchase central station power, the decision to install a separate power generating unit, etc.

Power sources. In general, factory power may be either generated within the plant or purchased from a local utility. The former is usually referred to as isolated plant power, and the latter as central station power. The decision regarding which type to use is an important managerial decision which should be preceded by a careful engineering study of all possible alternatives and their relative economies.

Considering only the electrical power requirements of the factory, the power may be supplied by (*a*) steam plants using either reciprocating engines or steam turbines; (*b*) hydro-electric plants; (*c*) gas-engine plants, using producer, natural, blast furnace, or coke-oven gas; (*d*) internal combustion (other than gas) engines employing fuel oil, gasoline, or other liquid fuel.

In the larger isolated plant installations the steam turbine, because of its high efficiency, is finding increasing favor. These may be operated from coal, gas, oil, or coke-fired boilers. The diesel electric generating system using fuel oil is often used in the medium-sized and small isolated plant installations. Improvements in diesel engine performance and economy of operation have done much to increase the use of this source of power in isolated plant installations.

There has been an increasing trend throughout the years to use central station service in place of the isolated plant installation. Because of large-scale power production the central station can take advantage of economies not possible in the isolated plant, and is often able to supply power at cheaper rates than could be supplied by the isolated plant. Possible interruption in power supply is an important factor in the choice of the source of power. In large cities the continuity of service supplied by the local utilities often excels that possible of the isolated plant unless elaborate reserve equipment is available in the isolated plant installation. On the other hand, a factory situated in an outlying area and supplied by long overhead transmission lines is subject to interruptions during adverse weather conditions. The location of the plant with respect to the central station and the facilities used to transmit the power to the plant may have an important bearing upon the degree of continuity of service.

Exhaust steam for heating. In isolated plant installations using steam power, it is sometimes the practice to use the exhaust steam for heating the plant or for processing operations. In the case of steam turbines, the steam may be bled from one or more of the turbine stages. Although exhaust steam heating provides an economical means of obtaining electrical power and heating the buildings, thereby serving a double purpose during the winter season, this method may prove uneconomical during the remainder of the year. During the time that the exhaust steam is used for heating or processing, the power is a by-product. During this period of time it is customary to charge only the interest on the power-generating apparatus, maintenance, repairs, and attendance against the power installation.

Central station power. The central station, manufacturing electrical energy in large quantities, owing to the refinements in apparatus which it uses, and which are not usually feasible for the small isolated plant, can deliver current at its switchboard at a much lower cost than many isolated plants. Even adding to the cost of current, as calculated in the preceding paragraph, the cost of distribution, it can often deliver current at the terminals of the customer's meter in a moderate-sized plant at a lower cost than the customer can make it for himself. This also applies in many cases where the power user must install a separate steam plant for heat in winter, and for steam used in processes. Unless an isolated plant is of such size that it will pay to install apparatus approaching in economy of operation that of the central station, or unless the steam required for processing and heating is of such volume as to utilize the entire exhaust from the prime mover, central station power will usually prove the cheaper. As a rough rule, if central station power is available it will seldom pay to generate power on the premises unless there is use for nearly all the exhaust steam. This rule is not to be followed too rigidly,

for local rates and other considerations may be controlling in individual localities.

Combination of central station and isolated plant power. It is sometimes advantageous for the industrial plant to generate some power locally and purchase the balance. Utility rates often include a "maximum demand" rate based upon the peak value of power used averaged over a specified period of time. It is therefore to the advantage of the industry to keep the maximum power demand as low as possible. This may be accomplished by staggering the operation of the power-driven factory units. An isolated plant may be installed to supply a part of the power during the periods of heaviest demand. In unusual cases where extreme continuity of service is required, special standby generators are installed to supply the power in the event of interruption of central station power supply. Such generators could be used during the peak periods to reduce the maximum demand on the utility system.

No definite rule can be laid down about the best method of obtaining power in any particular plant. Whether to buy all or part of the power required from the central station must be determined on the merits of each case, all the factors being taken into consideration.

Reliability of service. Reliable service implies comparative freedom from interruptions in power. In a large city, where central station power is distributed by an underground network, and especially where there are two or more central stations connected to the network, the reliability of service is very high, often approaching or equaling 100 per cent over a period of years. On the other hand, plants located long distances from the central stations and depending on aerial transmission lines have suffered shutdowns for days because of weather conditions which put the transmission system out of operation. The relative location of the central station and the industrial plant should be considered in adopting central station power.

Reliability of service in the isolated plant requires adequate reserve capacity for handling all probable contingencies. Careful operation and reasonable attention to maintenance and repairs are essential to assure continuous service and long life of the equipment. Adequate fuel supply must be kept available. The equipment must be of sufficient size to supply the factory load without overloading.

Fuel storage and service. The reserve supply of fuel is an important consideration in all power calculations. A plant so located that it is accessible to its source of fuel, as on a railroad line connecting directly with the coal mines, or on a water-course providing all-year transportation from the mines, need carry only a small reserve. If, however, it must depend on trucking its fuel, or is in a district inaccessible to the mines, or on railroads which may be interrupted in winter, the fuel re-

serve must be large. The interest on the investment in the fuel so carried is a proper charge on the cost of power, as is also the interest on the value of the real estate used for storage, together with the taxes, etc., on it.

Central stations usually carry adequate reserves of fuel, and are so located as to receive and handle these reserves in the most economical manner. The cost of the fuel reserve is, of course, included in the rates charged for power. In choosing between isolated plant or central station power, the question of fuel supply and reserve must not be neglected.

Alternating current vs. direct current. There are two types of power systems in general use: (*a*) alternating current, and (*b*) direct current. Most factories which have central station power use alternating current. Some of the larger metropolitan areas still have direct current systems but these are gradually changing over to alternating current.

The advantage of alternating current is that the transmission voltage can be stepped up or stepped down at will by the use of a relatively inexpensive transformer, whereas direct current power must be transmitted and used at the same voltage at which it is generated. Alternating current power can therefore be transmitted over hundreds of miles at high voltages with very little loss. The greatest distance over which direct current power can be economically transmitted in large amounts at the voltages ordinarily used for industrial purposes is approximately a thousand feet.

From the factory viewpoint, direct current motors are more flexible in operation than alternating current motors of comparable cost. The speed of direct current motors can be continuously variable over a wide range of speeds. The alternating current induction motor, which is commonly used for industrial drives, has only a very limited range of speed variation. The speed can be made to vary in steps, that is, full speed, half speed, and quarter speed. In large size motors, however, the auxiliary equipment for such speed variations is costly.

Load factor. Before considering whether or not central station power is advisable in a particular case, it is well to have an understanding of the method by which rates are fixed for central station power. The load on a power station varies from hour to hour, and the maximum load is much in excess of the average load. Nevertheless, the station equipment must be of sufficient capacity, and enough boilers must be kept under steam, to enable it to respond instantly to any demand that may be made upon it. Further, the distribution system must have sufficient capacity to supply the maximum power demand. The *load factor* of a given industrial plant is the *ratio of the average power used to the peak power used.* The average and peak powers are averages over specified intervals of time.

It is sometimes possible to carry on certain operations requiring large amounts of power during the night or other periods in which the central station equipment is lightly loaded. The charging of batteries, heat treating, and similar operations are often scheduled for a midnight shift to take advantage of special rates frequently offered by power companies. Some companies using considerable electric power and operating two shifts close the day shift about 4:30 in the afternoon and begin the second shift about 11:00 P.M.

Power-factor. *Power-factor is a term applied to the ratio of the power actually developed by an electric generator to the energy apparently developed.* With direct current the power developed can be ascertained by multiplying the reading of the voltmeter by the reading of the ammeter on the switchboard, the product being the power in the circuit in watts. With alternating current this product does not usually represent the power developed and other means of ascertaining it must be utilized.

With alternating current the energy in the circuit available for doing work is represented by (voltmeter reading × ammeter reading × power-factor). The power-factor takes account of the fact that the alternating voltage and current in the circuit may or may not reach a peak in the cycle simultaneously. If the peaks of the current and voltage in the alternating cycle occur simultaneously the value of the power-factor is 1.0 or unity. Lighting loads using filament lamps constitute unity power factor loads. On the other hand, induction motors, arc welders, electrical furnaces, and many other types of factory equipment are such as to cause the current in the circuit to reach its peak value in the cycle a short interval after the voltage has reached its peak. This lag of the current reduces the value of the power factor, making it necessary to supply a larger amount of current for a given amount of power. A few types of electrical equipment such as synchronous motors can be made to cause the current to reach its peak a short interval ahead of the voltage or the current leads the voltage.

Obviously, the ideal condition would be to have all unity power-factor loads, since this would result in the minimum amount of current for a given amount of power. This is usually not possible since induction motors, welders, and furnaces are often required in the operation of the factory. If, however, an induction motor and a synchronous motor are connected to the same line the induction motor current will lag the voltage while the synchronous motor current can be made to lead the voltage. These effects will neutralize each other and, if properly adjusted, the current supplied to the combined load will have unity power-factor, and thus only useful current will be required of the generator and transmission system.

The disadvantages of low power-factor lie in the fact that it requires the generation and distribution system to supply an excessive amount of current for the power required. Larger generating and distribution equipment will therefore be required to supply the power than would be required for unity power-factor loads.

It is customary for utilities to include a low power-factor penalty clause in the rate structure. This is to compensate for the necessity of having larger equipment to supply the lower power-factor load. It is therefore sometimes desirable, from the customers' viewpoint, to install synchronous motors or other power-factor correcting equipment to maintain high power-factor on the system. Unfortunately, the applications of this type of equipment are somewhat limited in the factory. Synchronous motors are constant speed motors and can therefore be used only where constant speed drives are required.

The same disadvantges of low power-factor apply to isolated plants as to a central station, except that in the case of an isolated plant they may be more serious. Owing to the distribution of the central station load among many customers, low power-factor in one plant may be balanced by high power-factor in another. The isolated plant, however, can overcome low power-factor only by judicious selection of equipment, and sometimes only by an expensive change in equipment.

Electric rates. The cost of supplying consumers with power is made up of several items in addition to the actual cost of the current itself. Theoretically, each customer should bear his proportion of the cost of the distribution system from the central station switchboard to his own meter terminals. Whether or not any current is used in a given month, the distribution system is there, and the charges on it must be met. Then, too, certain electrical losses occur in the distribution system and transformers, even though no current is used. These losses are a fair charge on the customer. In addition, there is the cost of keeping in service the surplus equipment to meet the peak-load power demands.

The method of charging these costs to the consumer varies with different companies and in different parts of the country. Some companies have a service charge to cover the cost of the distribution system which is a flat rate irrespective of the amount of current used, with an additional charge for the actual amount of electrical energy consumed. In addition, there may be a stand-by or readiness-to-serve charge to cover the cost of surplus equipment kept available for the customer's use.[1] This is on a sliding scale and decreases as the quantity of current used

[1] The stand-by charge is not a part of all rate schedules. Some companies use only the "demand charge" to cover the costs that are independent of the number of kilowatt-hours used and the "energy charge" to cover those costs that are proportional to the number of kilowatt-hours of energy used.

increases. Then, for the actual amount of current used, there is a charge on a sliding scale, decreasing as the use of current increases.

While the form of contract and schedule of rates vary with different companies, that of the Public Service Company of Northern Illinois may be taken as fairly typical. (See Fig. 70.) This schedule is not the only one used by this utility, but it illustrates the problem of rates.

FIG. 70

EXCERPTS FROM TARIFF OF RATES—PUBLIC SERVICE COMPANY OF NORTHERN ILLINOIS

INDUSTRIAL ELECTRIC SERVICE—RATE 46

Rate. Initial Demand Charge, Monthly Basis. If the Customer shall have been served during the entire next previous peak period under a rate similar to this Rate (that is, a rate having the demand period divided into "peak," "daytime" and "nighttime" periods), the Customer shall be billed under the peak, daytime and nighttime demand charges shown below, and his peak demand charges shall be based upon the same peak maximum demand as billed upon during last month under preceding rate, until peak demand charges shall have been billed upon such peak maximum demand for a total period of 12 months under this and preceding rate, unless in one of such months a higher maximum demand shall occur during peak hours . . .

Peak Demand Charge, Yearly Basis. The "peak period" is defined as the period of time between the hours of 4:00 p.m. and 8 30 p.m. of each day in the calendar months of November, December, January, and February, except Sundays, Thanksgiving Day, Christmas Day, New Year's Day, and Washington's Birthday; or such other 4.5 hours of each day of any 4 months, Sundays and certain legal holidays excepted, as the Company shall elect, upon the Company giving not less than 3 months' written notice to the Customer of change in such hours, days, or months.

If the Customer shall use service during any peak period, he shall pay, in addition to any "daytime" and "nighttime" demand charges and in addition to energy charges and all other charges, a peak demand charge determined as hereinafter stated, in accordance with the following schedule

$2.15 per month per kilowatt for the first 200 kilowatts of the number of kilowatts constituting the basis for the peak demand charge for the month.

1.50 per month per kilowatt for the next 800 kilowatts of the number of kilowatts constituting the basis for the peak demand charge for the month

1.40 per month per kilowatt for the next 2500 kilowatts of the number of kilowatts constituting the basis for the peak demand charge for the month.

1 15 per month per kilowatt for the excess over 3500 kilowatts of the number of kilowatts constituting the basis for the peak demand charge for the month.

Daytime Demand Charge, Monthly Basis. "Daytime" is defined as the periods of time between the hours of 7 30 a.m. and 10.00 p.m. of each day, except those periods of time in the "peak period," as defined above.

If the Customer shall use service during any daytime period in excess of the kilowatts constituting the basis for the peak demand charge billed in such month, he shall pay for such month, in addition to all other charges, a daytime demand charge upon the maximum demand established during daytime period in accordance with the following schedule, after there having been offset in the following table of kilowatts of maximum demand a number of kilowatts equal to the number of

kilowatts of peak maximum demand constituting the basis for peak demand charge billed in such month; such offset to start with the first block of the following table of maximum demands and progress to, into, or through each successive block until there shall have been offset a number of kilowatts equal to the number of kilowatts of peak maximum demand constituting the basis for the peak demand charge billed in such month, the daytime demand charge thus being calculated on the number of kilowatts in excess of such offset and at the rates applicable for the respective blocks in which such excess falls:

$1.35 per month per kilowatt for the first 200 kilowatts of daytime maximum demand in the month

1.00 per month per kilowatt for the next 800 kilowatts of daytime maximum demand in the month.

0.90 per month per kilowatt for the next 2500 kilowatts of daytime maximum demand in the month.

0.75 per month per kilowatt for the excess over 3500 kilowatts of the daytime maximum demand in the month.

Nighttime Demand Charge, Monthly Basis. "Nighttime" is defined as the period of time between the hours of 10:00 p.m. of each day and the next succeeding 7:30 a.m. If the Customer shall use service during any nighttime period in excess of the kilowatts constituting the basis for the peak demand charges billed in such month and also in excess of the daytime maximum demand established in such month, he shall pay for such month, in addition to all other charges, a nighttime demand charge upon the maximum demand established during the nighttime period in accordance with the following schedule, after there having been offset in the following table of kilowatts of maximum demand a number of kilowatts equal to the number of kilowatts of peak maximum demand constituting the basis for peak demand charge billed in such month or a number of kilowatts equal to the number of kilowatts of daytime maximum demand established in such month, whichever is the larger number; such offset to start with the first block of the following table of maximum demands and progress to, into, or through each successive block until there shall have been offset a number of kilowatts equal to the number of kilowatts of peak maximum demand constituting the basis for the peak demand charge billed in such month or a number of kilowatts equal to the number of kilowatts of daytime maximum demand constituting the basis for the daytime demand charge billed in such month, whichever is the larger number, the nighttime demand charge thus being calculated on the number of kilowatts in excess of such offset and at the rates applicable for the respective blocks in which such excess falls:

$0.85 per month per kilowatt for the first 200 kilowatts of nighttime maximum demand in the month.

0.70 per month per kilowatt for the next 800 kilowatts of nighttime maximum demand in the month.

0.60 per month per kilowatt for the next 2500 kilowatts of nighttime maximum demand in the month.

0.55 per month per kilowatt for the excess over 3500 kilowatts of nighttime maximum demand in the month.

General Provisions. . . . The above specified rates are based upon utilization of the Company's service at a power factor of 80% and it shall be the privilege of the Company, at its option at any time, with the approval of the Illinois Commerce Commission, to institute a policy of measuring the power factor of the Customer's utilization and adjust the charges under the herein specified rates for variation of utilization power factor below said 80%.

Distribution of power within the plant. An item that has received all too little attention in the distribution of power in an industrial enterprise is the adequacy of the power wiring installation. "A power wiring installation may be considered adequate when due weight has been given to each of the following factors:

a. Safety and reliability.
b. Avoidance of excessive voltage drop.
c. Avoidance of excessive copper loss.
d. Flexibility in changing locations of equipment.
e. Provision for supplying increased loads." [2]

Each of the items above is essentially technical in detail. Management's major function is to secure competent engineering advice and to be able to evaluate this advice when secured.

Adequate power. The term "adequate power" will have different meanings in different industries, owing to the different character of demands on the power system. In a textile mill the power required per machine of each type is a relatively constant quantity, and adequate power here means sufficient power to run the maximum number of machines that may be in operation at one time. In a rolling mill, on the other hand, the power demands at each stand of rolls will vary from minute to minute, depending on whether the rolls are breaking down ingots or giving the final finishing pass to the rolled section. In machine shops, adequate power means power actually delivered at the cutting points of the tools in sufficient quantity to take all cuts at the highest possible speed consistent with the conditions of the work.

The delivery of adequate power to the cutting tools—or to the point of application of power in any machine—involves adequate strength in all the transmission machinery, including machine gearing, belts and shafting, and minimum losses in bearings, motors, gears, chains, belts, engines, generators, and boilers. Many companies are suffering from lack of adequate power, not because they have insufficient boiler or engine capacity, or motors apparently too small for the job, but from lack of attention to the connecting links between the primary source of supply and the point of application of the power.

Adequate power is an engineering problem from start to finish. The wisest management will be guided by the advice of engineers in its solution. A few hundred dollars spent for engineering services may easily result in the saving of several thousand dollars of operating cost annually.

Single-motor main drive. The single-motor main drive has little to commend it except low first cost. It is largely a survival of the days

[2] Industrial Committee on Interior Wiring Design. *Handbook of Interior Wiring Design*, Third Edition, 1937, p. 53.

when the entire factory was driven by a waterwheel or from the flywheel of a steam engine, before the electric motor permitted power to be distributed in any direction and in any quantity desired to any part of the plant. In effect, this drive consists of a motor large enough to carry the maximum load that may occur at any one time, belted to a main line-shaft. This line-shaft drives, through belts or other connections, jack-shafts which in turn drive the machine countershafts. (See Fig. 71.) The disadvantages of this system are so many and so great that it should not be considered except under exceptional circumstances.

Group drive. In the group drive, instead of the jack-shafts being driven from a main line-shaft, each is driven by its own motor. (See

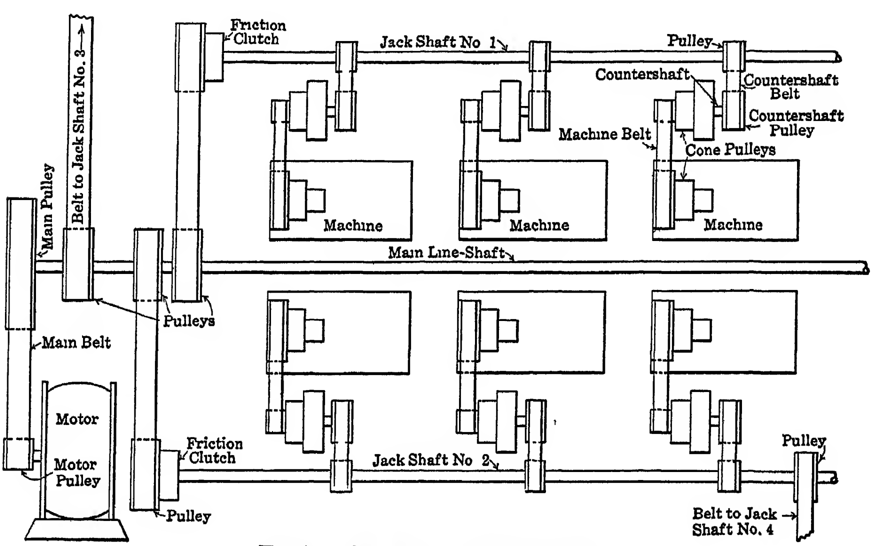


FIG. 71. Single-motor Main Drive.

Fig. 72.) Or the line-shaft may be cut into sections, each driving a group of machines, each section being driven by its own motor. Or, the various machines of each class may be arranged in groups, and the shafting for each group driven by a single motor. This system, while of greater first cost than the single-motor main drive, is so much more flexible and has so many inherent advantages, that it is the one most generally used. With it the shafting friction losses are lower than with the single-motor drive, and any section of the shop can be run at any time without having to drive all the shafting. The machines can be arranged more conveniently for the work, without regard to the position of main line-shafts, and without quarter-turn belts or mule-pulley stands to permit power to be taken off the main line-shaft at right angles to it.

called on to carry, and the load-factor and power-factor, hence the efficiency of the system will be high.[3]

Individual motor drive. In the individual motor drive, each machine has its own motor, either mounted on it and driving through gears or silent chain, or mounted close by and driving through a belt. (Fig. 73.)

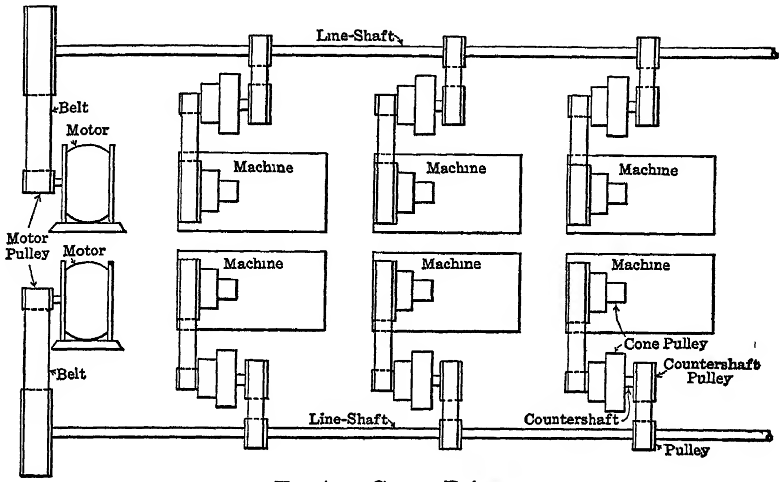


FIG. 72. Group Drive.

This is the most flexible of all systems, and permits machines to be arranged in the manner and position most suitable for the work without any regard for the source of power. It is highest in first cost, and the total horsepower of motors to be installed is greater than in either of the other systems, since each machine must be equipped with a motor large

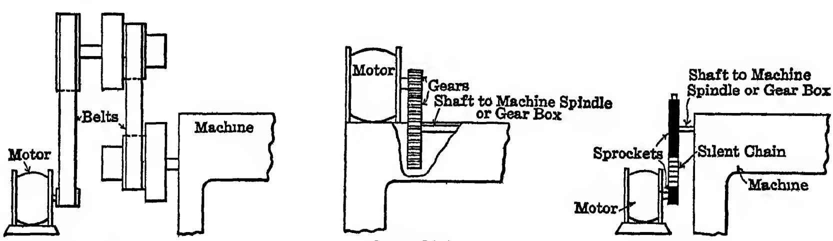


FIG. 73. Typical Arrangements of Individual Motor Drive.

enough to pull the heaviest load that may come on the machine, and also because the efficiency of electric motors increases with their size. This will tend to make the load-factor low and also the power-factor if alternating current is used. In the group drive, the motor usually

[3] This statement is made on the assumption that alternating current is being used.

need be only large enough for the average load, since it is quite unusual for every machine in a group to be under maximum load at the same time.

Combination group and individual motor drive. Probably the most satisfactory system of driving, particularly in the metal-working industry and in those industries where the demands for power on the several machines is variable, is a combination of the group and individual motor drives. In this system the machines requiring a relatively constant amount of power are driven in groups, while those requiring a large amount of power at irregular intervals are equipped with individual motors. This gives a very flexible system and smooth operation. It is highly undesirable to connect to the same shaft machines using a comparatively small quantity of power, such as screw machines and turret lathes, and machines taking large drafts of power at irregular intervals, such as punch presses and heavy planers. The combination system solves this problem in a very satisfactory manner. The load-factor will be comparatively high and the power-factor with alternating current moderately so.

PART IV

THE PRODUCT

CHAPTER XIV

PRODUCT DEVELOPMENT AND RESEARCH

The relationship of size and age of an enterprise to leadership in research and design. The new business, unless it be formed to manufacture a new type of patent-protected article for which there is or can easily be created an immediate demand, will probably depend upon imitation of competitors' products, either in its entirety or with slight modification. As the business grows in stability and gains a reputation in its field among the possible sales outlets, it can pioneer the design and construction of a product with some assurance that the product will find some acceptance because of a reputation created. As customer acceptance is developed for a particular product and some assurance can be had of a continued market, it is then that process development can take into account all that is newest and best both in materials and in equipment, with some degree of assurance that investment will be returned and profit made on outlays for equipment. The foregoing discussion is typical of the growth of most enterprises. These statements of course would not be representative of a new undertaking sponsored by a large organization such as the E. I. du Pont de Nemours & Co., Inc. which has at times conducted exhaustive researches in its main laboratories and then built complete plants with the last word in technical equipment to exploit the findings of its researches.

Conflicting interests in product design. It is in the development of the manufacturing process that conflict between the sales and production departments of a business causes major management decisions to arise which only the general management can make. The sales division tends to work towards diversity, while the production group strives for standardization. The design engineer who can devise means of creating diverse appearing products from materials and processes that are standard is usually the leader in his field. The managerial factors which exert an influence in the direction of standardization include:

1. Lower investment in plant, equipment, materials, and finished inventory.
2. Resultant price reductions, enlarging market for product.
3. Interchangeability of parts, if mechanical product.
4. Possibility of development of automatic equipment, or standardized chemical or mechanical controls.

The factors tending towards diversity include:

1. The necessity of meeting various consumers' needs, desires, and purchasing capacities.
2. Sales appeal through product changes, giving the appearance of being up to date.
3. Price competition, making possible the securing of orders if price is shaved slightly by changing construction of the product in minor details.
4. Necessity of meeting several competitors' products of varying design, or made from varying materials.
5. Limitations imposed by process or design patents of selves or competitors.
6. Desirability of developing several competing but dissimilar lines to enlarge the number of retail outlets.
7. The continued development of technical processes and equipment and adjustments to take advantage of the possibilities of these developments.

Economic considerations. If by chance a company has secured command of its field on a particular product the tendency will naturally be towards development of the manufacturing process so as to reduce price and prevent competition from arising, in so far as that is possible, but if competition be severe, and particularly if the product be one that is influenced by style trends or by technological developments, great investment in specialized production equipment will be justified only if the resultant savings can be promptly realized. Investment in machinery and equipment must be gauged by the immediate savings which will be made, by the necessity of reducing production costs to meet competition, by the likelihood of new processes being developed to replace the equipment whose purchase is being contemplated, by the life of the equipment, by the condition and manufacturing possibilities of the equipment already owned, or competitive equipment which may be purchased, and by the prospective length of life of the design of product on which it is contemplated to use the new equipment.

Research and analysis tell the factory owner that he can improve his product, or cheapen its price by the betterment of his production facil-

ities, but similarly in times of depression, he knows that he must maintain his balance sheet in the most liquid condition possible, that he must scrape along with the old-style machine, or the old-style process a little longer, no matter how dissatisfied with it he may be. Again, large aggregations of capital secure their greatest relative advantages in depression times. Enterprises in a strong financial position do not lay off their research workers; they do not stop process development; they keep at work, bide their time, and at the turn of business produce commodities that are irresistible, speaking figuratively. Their competitors then attempt to follow, and those that are unable to do so because of financial or patent reasons are soon out of the race. Thus it is that many large corporations will not introduce new equipment which will not pay for itself in a relatively short time, two or three years, or perhaps as short a time as six months. Why? Because in the race to betterment, there is no assurance that within several years a new process, or a new product will not have made the projected new piece of equipment a piece for the museum or the second-hand machinery merchant.

Historical background of product design and research. Such rapid progress has been made since the turn of the century in product development and research that we are prone to underestimate the contributions of the past. A critical evaluation with full appreciation of past achievements, in the light of the former limited techniques and equipment, should inspire rather than handicap the present investigator.

Before the discovery of America the natives of Guatemala were using fast vegetable dyes. The early Egyptians processed copper in a manner which has been claimed to defy duplication even today. The early history of China reports the use of gunpowder. Five thousand years ago the Mongolians were using tea leaves to treat burn trauma, while the Henry Ford Hospital of Detroit announced its modern counterpart in 1925 by giving the world the tannic acid treatment for burns. Modern scientists are striving to unlock the historical past. The Rockefeller Institute has sent an expedition into the jungles of Brazil to study the herb treatments, hoping to discover in these herbs principles which can be utilized but which are unknown to the world at large today.

Far-reaching though these earlier inventions were, man still was largely subject to the use of materials essentially as they were provided by nature. Many of these materials of nature were not as satisfactory as man would have had them be; they were heavy when he would have preferred them light, soft when he wanted them hard, and solid when they should have been liquid. It remained for the more exact scientific methods of the nineteenth century to free man from many of these former handicaps. Schoenbein nitrated cotton and obtained nitro-cellulose, to be followed by Hyatt, who discovered how to plastacize nitro-cellulose

to make a pliable product. Du-Chardonnet completed this nitro-cellulose cycle by spinning the first filament.[1] Despite the fact that we think of rayon as a modern product, its early beginnings appeared in the middle of the last century. Today American chemical research as related to rubber and synthetic fabrics ranks second to none in the world, as does our medical research. We have long led the field in mechanical research and development. It is the opinion of many of our scientific investigators that our task has just begun and that the future promises to be brighter than the past.

Different kinds of research. In the field of industry and commerce we are primarily interested in research in the economic and social sciences and research in materials, equipment, and processes. Industrial management concerns itself largely with research in materials, equipment, processes, and the product. Research may be defined as the search after new information by the experimental method. Pure research seeks truth for its own sake without regard to its utility, whereas applied research seeks to solve specific problems with consumer utility as a direct incentive. Some authors have used the terms, *extensive or fundamental* research, when referring to pure research and *intensive research* as applicable to the effort to solve specific industrial problems. Intensive research strives to enlarge our knowledge about existing things or things that might well be, so as to enable us to improve them, reduce their cost, or both, as well as to create a new utility or service. Extensive research seeks to extend the frontiers of our knowledge for its own sake. Both types of research have a place in our social structure and neither can truthfully claim any superior status over the other. An industry which neglects research will survive foreign competition for a time only by cowering behind tariff walls. Industry is primarily engaged in intensive research, however extensive fundamental research serves as a stimulus to more effective intensive research.

Organization for product design and research. It is doubtful if there is any phase of organization where specialization gives greater returns than in the field of design and research. Creative work of any type requires time. Many phases of design and research are futures requiring painstaking preparation and exhaustive investigation. Active participation in production routine is not conducive to this type of work. It will often be neglected entirely unless the particular executive has a special personal liking for this type of work, in which case it is not infrequent that production suffers from lack of attention.

[1] Much of the material in this Chapter is adapted from a speech delivered by Paul F. Ziegler, Research Director of Bauer & Black, Chicago, Illinois, before the Chicago Chapter of the Society for the Advancement of Management, March 15, 1938.

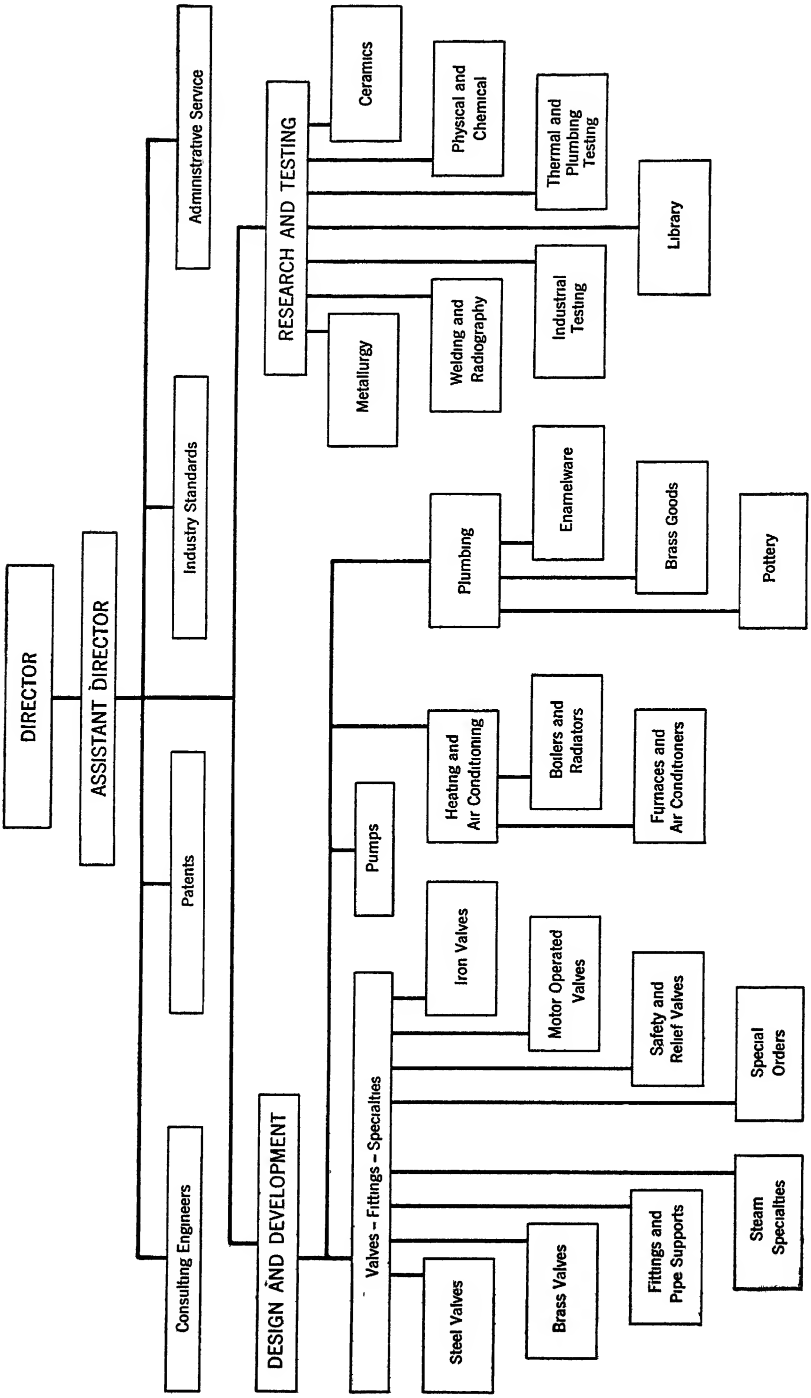
The essential conditions that foster research and product development are time to pursue the investigations, an inquiring state of mind supported by sufficient effective training or experience in systematic investigation, and the necessary facilities to carry on the research. The mistake is often made of laying the major emphasis on buildings and equipment, while in reality the buildings and equipment may be meager for most research, provided the state of mind is right and time is available to pursue the inquiries.

The product engineer should occupy a position of trust and responsibility in the organization. In many of the larger organizations he is a vice president on a par with the salesmanager and the factory manager. The research division may be a section of product engineering; product engineering may be a division of research; or the two may be entirely separated. Where the two are joined in the same organization there is more likelihood of a closer tie-in with actual production problems If research is really to function, it must be allowed to work on its primary objective and not have its efforts expended on tasks that belong to the producing departments or inspection. It is always a temptation, particularly in highly technical processes, to call upon the research or development department when production encounters difficulty. It should further be observed that regardless of the position in the organizational structure of the product engineer, to be effective he must work closely with the production, purchasing, and sales departments.

Figure 74 illustrates the organization of the research and engineering divisions of the Crane Company, Chicago, Illinois, manufacturers of valves and plumbing equipment. The exact organization of these functions of a given enterprise will depend somewhat upon the varieties and the nature of the products, the basic organizational philosophy of the major executives, and the personalities involved. The organization, like the other phases of manufacturing, is dynamic—not static.

Some fundamental considerations in product design. The persons charged with the responsibility of product design must bear constantly in mind certain basic fundamentals or their efforts may not be most efficiently directed. A few of these considerations may be stated as follows:

1. The desire of the consumer for utility, quality, style, and color, within a given price range must never be ignored.
2. The cost of product development must be kept within the capacity of the business enterprise to pay.
3. Due regard must be given to the effect of introducing the new product upon the rest of the company's products, both from a selling and a manufacturing point of view.



Courtesy The Crane Company.

FIG. 74. Organization Chart of the Engineering and Research Division, Crane Company, Chicago.

4. There is need for co-ordinating the various departments interested in design, such as the methods department, the manufacturing division, the purchasing department, the sales department, and last but not least the finance division.

1. *The consumer.* The major objective of a business enterprise is the satisfaction of consumer wants in order to realize a profit on operations. Since production is largely in anticipation of demand, it is necessary to anticipate the consumers' desires in marketing a new product or an improved or changed one. The consumer wants not only style and color but utility. A vital factor from the standpoint of consumer utility is ease of maintenance. The product engineer should strive for ease of accessibility for maintenance and keep in mind that the product will be repaired in the field where facilities are not the same as in the producing plant. Low maintenance cost provides a strong selling point.

Some enterprises have sought to find out from the consumers themselves what they want in their product. Mr. Weaver of the General Motors Corporation has developed an interesting technique along this line. He sends out thousands of attractive booklets that show current designs, colors, upholstering types, improvements, etc. These are conveniently arranged so that the recipient may easily check his preference and insert the booklet in a return envelope. From these replies the corporation can measure with a high degree of accuracy what the consumer wants. There are special market research corporations that will undertake a consumer study for a fee. They may use a questionnaire or send out representatives to interview a representative sample of customers.

2. *Development costs.* It is unusual for a development engineer to be able to estimate accurately the cost of a given program at the time of his initial request. If it is a simple program and he knows exactly what has to be done his cost estimate will be fairly close. Such cases are rare in real development of a new product or process. Usually there are so many unknowns that about all that can be done is to give an enlightened estimate of expenditures to be made within a given time. Just how far the project will be advanced within this period of time it is difficult to predict. The sound procedure is to budget developmental and research costs and to keep an accurate record of all expenditures for each project. Such a program will tend to keep costs in a balanced relationship to each other and not permit all available funds to be spent in one direction when other problems are demanding attention.

3. *Co-ordination of various interests.* Should a new product compete directly with a product now in the line, management will have to decide in advance just what policy to pursue. Shall the product be mar-

keted with the same sales group or have a different sales organization such as is used by General Motors in marketing the Oldsmobile and Buick automobiles? Will the present manufacturing facilities be adequate for the old products as well as the new? In case the new product is the same in type but different in quality from the regular line, what will the effect of producing the new one have upon the production of the old line? Will the new product tend to lower or raise the quality of workmanship on the old if both are to be produced by the same workmen? These and other similar questions must be answered by management in advance of production if unfortunate results are to be avoided.

The logical method of resolving the various conflicts of interest is to have all interested divisions a party to the final decision. As a matter of fact, the design engineer may well consult the methods department and the manufacturing division as he progresses. Such co-ordination may easily result in modifications of design that do not interfere with the basic operation of the product yet make possible the use of present equipment, thus avoiding unnecessary expenditures for new equipment or later changes in design. The production department often may suggest modifications in design that result in marked savings in manufacturing costs. By working closely with the sales department the design engineer will have the benefit of the practical customer reaction as well as the enthusiastic support of the sales group in marketing a product for the design of which they feel some responsibility. The purchasing department may render valuable suggestions regarding economies in purchasing certain materials or parts that may be specified especially in terms of standards and dimensions that are used in the trade.

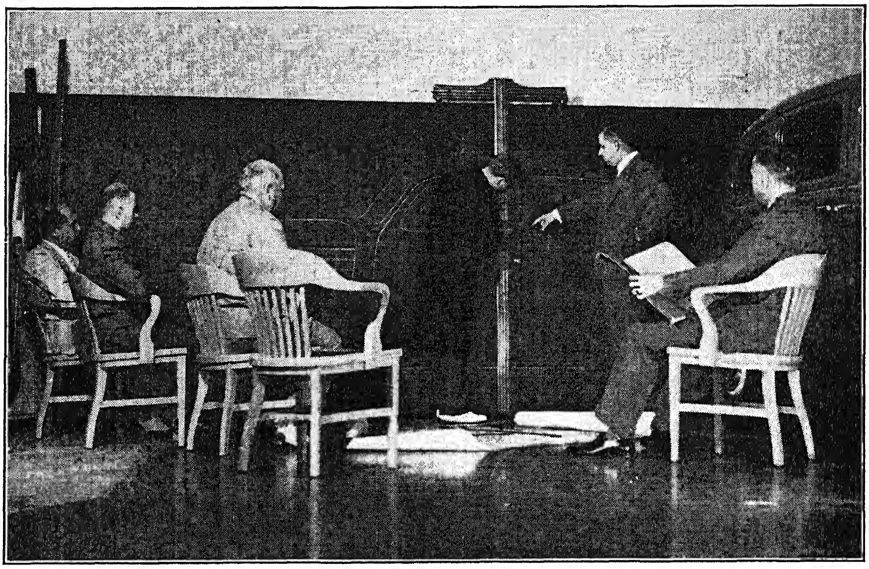
Procedures in product design and research. There is no one method that is used in all types of organizations and by different personalities. Some rare geniuses may violate all organizational principles and achieve outstanding results. This will probably always remain the case; however, modern industrial research has become a co-operative effort involving many men and a variety of technical specialists. With the increase in the number of persons actively engaged in research in many industrial enterprises, has come the necessity for established procedures and the delegation of responsibilities. The director of a large research department like the General Motors Research Laboratories must combine an inquiring mind and technical training with executive ability of a high order. He must be able to recognize questions needing answers and problems awaiting solution and have the capacity to select the most urgent ones at a given time and to delegate each problem or parts thereof to the person best equipped to handle it.

In a large or small development or research project at least two types of procedures may be used. One is to assign the entire project to one man

to follow through. He is free to call upon other specialists for help and advice wherever needed. The other is for the director or a committee to retain the active control over the project and to assign segments of the project to specialists, each specialist working on his phase of the work, sometimes without a full appreciation of the major objective of the entire effort. In either case there may be departmental meetings from time to time when the respective projects are discussed to acquaint the various persons with the work of the others and to get the collective thinking of the group focused upon a given project.

The original request or initiative for a given product design may come from a customer, the sales department, an officer of the company or the major executives as a group, or as the logical result of evolutionary product development arising out of the problems facing the business. In the case of an automobile, for instance, management may decide that it desires to produce a car that will sell in the $900 class. This, then, would become controlling factor number *one*. There being a fair relationship between selling price and weight of a car, the approximate over-all weight may be settled in advance. The next decision might well be wheel base, concerning which the sales department may agree merely to meet current competition; in this event the over-all dimensions are already established by the trade. Since there are many specialized parts to an automobile the chief product engineer would then assign to each special group its particular task and give each group approximate requirements as to weight for each unit and cost limits. Some of these special units are the frame, lubrication of chassis, the engine proper with a subdivision of ignition, clutch and transmission, spring suspension, wheels and tires and body. Each of these major heads may have several subdivisions such as the body, which will have at least body contour, paint, trim or upholstering, and body hardware. Since practically all cars give satisfactory performance, the actual mechanical working parts are fairly well standardized and established practice may be followed with minor improvements that may reduce costs or increase efficiency. The general appearance of the car will greatly influence its popularity with the buying public; hence the body proper, cowling, and radiator must receive special attention as to design for styling appeal. A specialist may work on the rear, another on the side view, another on the windshield, one on the hood and cowling, and still another on the radiator. The composite efforts of these specialists may then be put together into one drawing to give the general picture of the projected product. This may have to be modified as the various parts may not harmonize. Another approach is to have an artist sketch the completed design and make changes until it meets the approval of the major executives, and then assign to each specialist his segment of work to harmonize with the approved

artist's design.[2] A temporary wooden or plastic model would then be made and painted and possibly upholstered to serve as a complete model. This may be changed until it receives final approval; the dimensions of the approved model would then be transferred to an aluminum sheet to avoid distortion arising from temperature changes in the room and from which body dies would be built, and from which actual production would later be run. Figure 75 shows body engineers at work. Any major mechanical changes that had not previously been tested on the road would receive exhaustive road tests before marketing the new car.



Courtesy General Motors Corporation.

FIG. 75. A Full-size Blackboard Drawing and an Engineer Determining the Body Construction for a New Model, Fisher Body Corporation, Detroit.

Responsibilities and contributions of the product design and research departments to other departments within the organization.[3] The product design and research departments may reasonably be expected to render certain special services to the other departments in the organization from time to time, especially to the sales department, manufacturing department, and the top management or administrative officers. It would be well to consider these services to each of these units separately.

1. *Sales department.* In the case of the sales department, the product

[2] Working from an artist's conception has become increasingly popular in recent years.

[3] Adapted from the speech by Paul F. Ziegler, *op. cit.*, pp. 6-9.

design and research divisions' first responsibility is with regard to the existing products. They must keep the products, which the sales department is selling, competitively at the top of the list of similar products within the given price range. This means constant improvements through research effort, and an alertness to the mechanical and chemical changes that are constantly going on in the fields of raw and semi-finished materials and finished products. In the automobile tire industry the research laboratories are constantly making complete detailed chemical and structural analysis of competitor's products. In other words, the research and design divisions must not be caught napping by competition.

Another responsibility of research to the sales division arises in the field of new products. A sales department has a right to expect from its product research and design divisions a reasonably constant flow of new products within the field of their operation. It is not meant that there be weekly possibilities of additions to the regular line, because this would be impractical from a sales viewpoint. A reservoir of possibilities should be available for addition to the line as they may be needed. These possibilities should be well beyond the laboratory stage; and they should have had some initial field tests, which may be conducted under the direction of the research and design departments. Conversely, it is the responsibility of these same departments to filter out from sales consideration allegedly new and useful products which have no scientific merit. Many of these suggestions come from inventors from the outside.

A third responsibility arises in connection with the interpretation of technical data and results so that these may be used to the best advantage by the sales department. Such technical helps increase materially the effectiveness of sales effort. The advertising function can be more intelligently carried out by a close tie-in with a sympathetic scientific group. This relationship implies a reciprocal responsibility, mutual respect, and intelligent co-operation.

2. *The manufacturing department.* The technical divisions must contribute their share to keeping the wheels of the plant moving—trouble shooting, in the language of the shop. In this connection reference is made only to those difficulties whose solution requires exact scientific knowledge. It is not infrequent in highly technical operations that troubles arise which defy interpretation, and thereby defy correction, troubles related to chemistry, physics, and engineering—and which can be interpreted only in the light of a knowledge of these subjects. It is in connection with these problems that the research staff may render a valuable service.

Another service that the research group may render to the producing group is control over certain highly technical processes. Most of the

production control in a manufacturing unit does not require the technique of a research department. On the other hand, certain operations in many industries require close supervision by somebody with research training in order to maintain the desired quality. This is especially true of manufacturers of pharmaceutical products and to a lesser degree in certain phases of rubber manufacture and in the steel industry. It should be apparent that the regular inspection department deals with quality maintenance in general and that the research department has no part in this function.

A third contribution of the research department to the manufacturing division is intensive research for the improvement of processes. This function in no way replaces the work of the mechanical department charged with methods improvements, but rather supplements their efforts, particularly in those phases of the process involving chemistry and physics.

3. *Management.* The major executives are charged not only with the formulation of company policies but also with initiating the necessary steps to put these policies into effect. The research and design activities can render valuable functional service to management in its long-range policy determination.

In all probability the most outstanding contribution of research to management is the detection of incipient changes that become indicated by the discovery of new facts and new intermediates, either within or without the given enterprise or industry, because it is within the realm of possibility today for a business to be ruined overnight by such scientific discoveries. The multitude of scientific discoveries that are emanating from the many university, industrial, and public laboratories challenge research ingenuity to evaluate them in terms of the organization's products. The newer scientific equipment also falls within this field, such as adapting the principles of the radio to the determination of noises in automobile transmissions and the use of the X-ray in detecting defective castings. The protection of an established enterprise requires this service. Discoveries such as the ones referred to in this paragraph, if not taken in stride by a company, may mean disaster or at least a costly period of readjustment. This is particularly true of developments arising outside of the company's own laboratories.

Another service of the research division is bringing to management's attention new products developed outside the organization of which the exclusive right to manufacture may be advantageously purchased. This is somewhat a different approach from new product development referred to under services rendered the sales department. It goes deeper than mere product design and often involves further development of a product the fundamental researches of which have already been carried

out by an outsider. Whatever scientific meetings are held, there are latent possibilities of industrial products or processes. It usually requires the applied research mind to detect new product possibilities in these embryonic stages. Management may reasonably expect this type of service from its research department.

A third responsibility of the product design and research departments to management is in the field of patents. While the actual patent litigation is handled by the legal staff, nevertheless much of the raw materials used by the legal division must be provided by someone else. Research and product design result in patents. The laying of a firm foundation for a patent policy goes right back to the laboratory notebooks and the records of the product design department, where intelligent and adequate disclosures should be made, samples and models developed and carefully filed away. The writing of patent specifications is a co-operative task between the research or product design representative and the patent attorney. In subsequent litigation the success of the firm often depends upon adequate records which have been properly kept and dated during the period of development and research.

CHAPTER XV

SIMPLIFICATION AND STANDARDIZATION OF PRODUCT

From a purely production standpoint, every organization should prefer to produce only one of each type of product in its line. Such a program, although Utopian from the standpoint of the factory manager, is impossible in all but a favored few plants. Demands of the trade and of individual customers make imperative the diversification of product that is necessary to meet various consumers' needs, desires, and purchasing capacities. In some industries, such as those in which taste and style are important factors, an attempt to produce but one product of each type would mean industrial suicide. However, through many years of practice in meeting the desires and needs of the customer, many organizations seem to have forgotten that there is manufacturing preference for fewer products. They have proceeded so unnecessarily far in diversifying their lines that it has taken a distinct movement toward simplification, carefully fostered, to bring into prominence the economic and profit-making reasons for the elimination of excessive diversity of product.

The meaning of simplification and standardization. In general production discussions the terms simplification and standardization are frequently used interchangeably. Some writers on the subject distinguish between simplification and standardization.[1] When the two terms are used to convey different meanings, simplification *refers to the elimination of superfluous varieties, sizes, dimensions, etc.* It is essentially a reducing process, the cutting down of the varieties and types with relatively little regard for the use of any scientific procedures or methods. It may well be described as an empirical process. On the other hand, *standardization refers to the setting up of fixed sizes, types, qualities, measures, etc. Standardization implies careful consideration of relationships and values usually involving scientific procedures.* Standardization usually involves a reduction in the number of sizes and types; however, it frequently requires the establishing of new sizes or types to take the place of some of the sizes or types eliminated. Standardization is

[1] See L. P. Alford, *Cost and Production Handbook,* The Ronald Press Company, New York, 1937, pp. 303-304.

primarily an engineering function which has a direct influence upon commercial usage and practice. Simplification lays less emphasis upon the engineering side of an enterprise and more upon the commercial aspects. While the foregoing distinctions are stressed among certain students of production for the purpose of clarity in use, it must be conceded that others with considerable logic use the terms interchangeably. Professor Kimball defines simplification as "standardization in a limited number of particulars." [2]

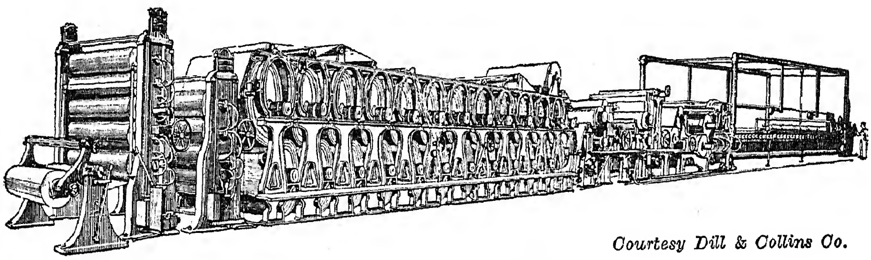
Causes of unnecessary diversity of product. Unnecessary diversity of product has resulted from two main causes. The first of these is the demand of the consumer for product that is individually different, either to meet peculiar service needs, or because of the style and taste factors. The second, and wholly remediable cause, is that sales methods have frequently been based largely on supply diversity. Although it will be seen shortly that much can be done toward the education of the customer in convincing him that his service needs fall under certain well-defined headings which may be supplied by standard products, and although taste and style demands for diversity may be modified, the most fruitful immediate attack can usually be made by revising sales methods so that they will eliminate, rather than cause, diversity.

Sales divisions, selling agents, and salesmen themselves all have felt that one of their strongest selling arguments was that a particular product was a "novelty," or that it was different from anything they or their competitors had before presented to the trade. In addition, they have frequently urged the retailers to stock a huge variety of the product they sell, on the basis of appealing to the consumer's individuality complex. This has been frequently unnecessary and costly to the retailer, as it has meant to him carrying charges and damaged-stock charges which have been many times what they should have been. By far the greatest cause of diversity of product has been the practice of selling on the basis of diversity in order to meet competition with a product that could not be easily compared, or with one on which quality or price could be readily shaded.

Results of diversity of product on production. The effect of selling policies such as those just described on the operation of the factory is such that the production costs mount rapidly and it is impossible to institute economies in operation which are simple with less diversified lines. The American Writing Paper Company, studying the losses involved in that type of selling method, reduced their line from 2000 separate varieties of paper to approximately 200. Some of the production reasons for this change well illustrate the importance, from a manu-

[2] Dexter S. Kimball, *Principles of Industrial Organization*, McGraw-Hill Book Co., Inc., New York, 1933, p. 275.

facturing standpoint, of the standardization of product. The key machine in the paper-making industry, the paper-making or Fourdrinier machine, a huge machine from 50 to 200 feet long (Fig. 76), must be stopped and started every time a new grade of paper is run through it. Not only must many time-consuming adjustments be made on the machine, but there is a huge loss of material from wastage of paper as the machine is being finally adjusted. Frequently the down-time cost on the machine plus this wastage will be sufficient to cause an addition to the cost of production of 10 to 15 per cent alone, when the runs of paper are short. In addition to these losses there will be the losses incident to idleness of



Courtesy Dill & Collins Co.

FIG. 76. Fourdrinier Machine.

equipment which performs subsequent operations on the paper, and operations which vary according to the type of paper being manufactured.

Benefits of simplification. The benefits resulting from simplification are many more than those represented by direct lessening of production cost. In addition to this there may be mentioned these: decrease in capital invested, lower labor cost, advance in the technique of production, improvement in equipment utilization and control, and possibility of speedy and reliable delivery, improved quality of product arising from concentration of effort, and increased turnover of capital invested in inventories. Together these insure consumer satisfaction because of prompt service at low prices; in addition to greater profits on the same investment for the manufacturer.

A decrease in the capital investment is brought about through the utilization of less machinery and fewer tools, patterns, and other auxiliaries, as well as through the reduction in the inventories of raw material, parts, or partly worked material and finished stock. Lower labor costs come with familiarity of the workers with their more frequently repeated tasks, as well as from the steadiness of employment that follows the well-defined production programs that can be mapped out when the product is standardized. Increased stabilization of employment is one of the major results that will come from further simplification.

As the technique of production improves, intermittency in the use

of equipment being eliminated, more expensive equipment, better suited to the standard product, can be bought, and cost reduction promptly follows simplification. The knowledge of the organization becomes specialized along narrower lines, and thus there is a tendency toward constant improvement of process. Simplification also brings with it production with less wastage of material. Thus, new styles of standardized metal beds use one-third less material than the old styles. Not only can equipment specially suited to the product be procured, but all equipment can be more easily assigned to the production of those numbers in the product to which it is best suited. Two machines of exactly the same type often show peculiar and unexplainable suitability for the production of different numbers of a similar product. With a reduction in the number of products made, it is possible so to control machine utilization as to take advantage of such conditions. Speedy and reliable delivery is possible even with reduced inventories because consumer demand can be more accurately gauged and production programs and finished stock adjusted to meet forecasts. Standards of quality and service come to be the basis of sales, instead of price shading and diversity.

The final success of such a program rests on the co-operation of the sales division or selling agent. Sales methods must be frequently changed, and, if not, the influence of the salesmen must be cast on the side of pushing sales of standard products rather than continually suggesting diversity. Co-operation between the sales and production divisions, through regular committees or through special conferences, is the first requirement in developing a workable program of product simplification.[3] The development of a budget of sales and production, as explained in later chapters, is probably the best insurance of successful operation. If this is not practicable, then each item of the line should be carefully gone over in the conference between the two departments, and the requirements of each thoroughly understood by the other before items are either added or dropped from the line of products.

Product standardization has all the advantages claimed above for simplification but even to a greater degree both within the producing and selling organizations and to the broader socio-economic relationships of the consumers.

Securing simplification. Some of the means that have been utilized by individual industries to secure simplification deserve mention. These include the revision of sales methods, the development of a succession of designs where novelty is an important factor, and the development of parts standardization.

[3] See Fig. 97, Chapter XIX, for a chart illustrating the Standardization System of a large electrical manufacturer.

In changing over sales methods to effect simplification, *the change is from arguments based on diversity and price-shading to arguments based on,* first, *better goods at the same price,* or *the same goods at a lower price,* owing to manufacturing economies; second, *service to the customer;* and, third, if the product be sold through dealers, *quicker turnover* and hence, lower investment, damage, and obsolescence charges. Such vital changes in selling methods at times necessitate changes in whole mechanisms of distribution.

Style and simplification. There are many businesses in which the style factor is so important that whether or not there shall be profits is determined largely by the stylishness of the product. Unusual profits are made by initiating style or, as it is sometimes known, "beating the market." Such businesses are women's millinery and apparel. In such cases, standardization of product over a period of years cannot be thought of. Despite the importance of novelty, taste, and style, much progress can be made in the standardization of texture of materials, as contrasted with design, and with the inner portions of the articles manufactured. Wherever possible, the addition of certain staple styles to the line does much to bring to the plant the benefits of standardization. In such industries much can be done in insuring the elimination of designs of past seasons at the time that new designs are added, thus keeping the total line to a given number of patterns. This idea of *succession of designs* is very important in all industries where taste and novelty enter into retail sales.

Parts standardization. Parts standardization is an effective way of simplifying the line if demands of consumers call for diversified lines, particularly in assembly industries. Products falling under this head include shoes, furniture, and automobiles. The experience of a large stove manufacturer clearly illustrates this step in standardization. The first items standardized were stove lids and stove centers, the crosspieces that hold the lids in place. There are from four to six of these on every stove, and the old method of making them was to have a different size cover for every stove. All types were abandoned except one, and this was made in 7-, 8-, and 9-inch sizes, thereby eliminating many patterns and much of the stock of castings. Next, the legs of the stoves were standardized. These were made in four classes, light legs and heavy legs, both with and without base strips. These four types were substituted for the great variety that previously existed. The bodies of ranges and cookstoves were next developed so that they could be trimmed with many nickeled parts or not, allowing three grades of stoves to be made from one size of body. Many auxiliaries, such as towel rods, swing shelves, lifters, and handles were standardized for practically all types of stoves.

The automotive industry has been able to standardize largely through parts standardization. Absolute standardization of the finished product has proved to be impossible for any factory, because of the varying consumer demand for size, price, type of body, and color. Although selling phrases in the automotive industry are largely "carefully drawn specifications," "no radical change," "manufacturing economies due to large production," nevertheless, in recent years style and color have been a large factor in sales. In order to develop style and standardization at the same time, the automobile has had an infinite amount of attention paid to detail standardization of its parts. The automotive industry, through the Society of Automotive Engineers, has led the country in developing standard specifications of bolts, screws, sheet steel, and other component parts.

In some very complicated industries, standardization has come about through the leadership of one company. Thus, in the pipe fittings and valve industry, the Walworth Company took a very conspicuous part in working toward simplification. It announced the elimination of sizes 4½″, 7″, 9″, 11″, 15″, and 22″ fittings and valves. Other manufacturers followed this lead in the elimination of excess variety with evident satisfaction, and the program was received with approval by dealers and consumers as well.

The movement toward product standardization. Large-scale adoption of programs leading to standardization of product by industries was first brought about in the United States through the action of the War Industries Board during 1917 and 1918. This board had found that one of the greatest obstacles to organization of the industries of the United States on a war basis was the utilization of time, material, and capital involved in unnecessary diversity of product. Starting with industries directly involved in the manufacture of war materials, it called conferences of leaders in each industry to develop a program for elimination of excess variety. Upon the basis of these conferences, action was taken. As an illustration of the enormous reductions in variety of product which were at this time brought about under the leadership of this board may be mentioned the reduction in the number of colors of men's hats to 9, as compared with approximately 100 distinct colors that several factories were previously producing. Another example is the reduction of rear gearings of farm tractors from 1736 to 16. Action in the case of industries closely allied with war operations was quickly followed by action in numerous other industries with a view to general conservation of plant capacity, materials, and man-power. Thus, after conference, the number of styles of chinaware was reduced to 330, a very considerable reduction from the 1130 patterns which one company had been producing.

Simplification within an industry is essentially a co-operative action, because one large company selling on the basis of diversity can make standardization very difficult for its competitors. The United States Chamber of Commerce, observing this, and seeing the advantages of simplification, undertook an educational campaign through its Fabricated

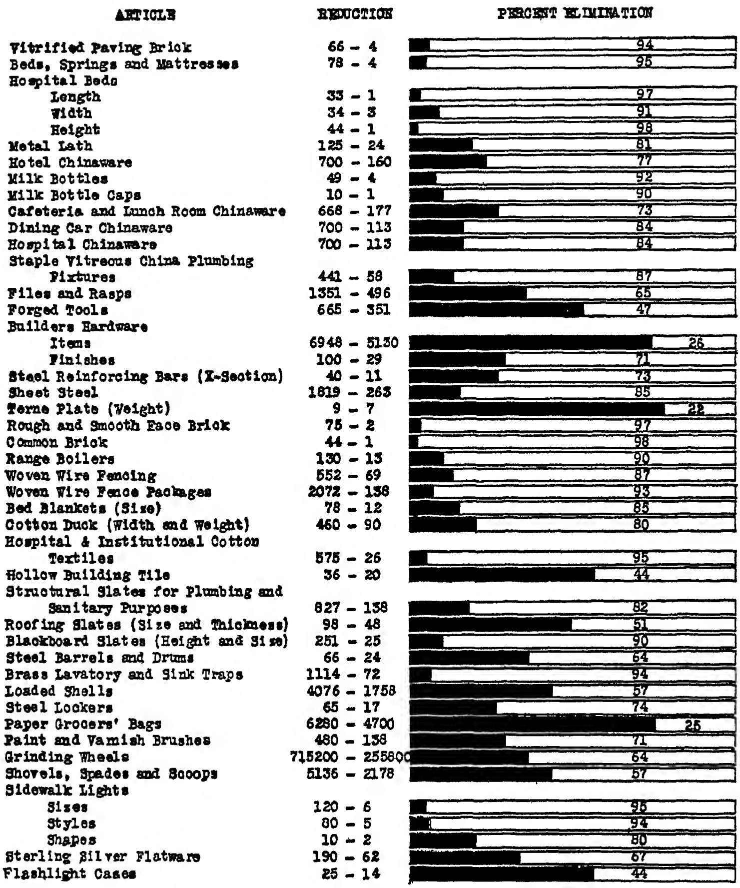


FIG. 77. Chart Indicating Percentage of Elimination of Variety of Product in a Number of Industries.

Production Division in 1920, organizing a movement which brought prompt results. In 1921 the Division of Simplified Practice of the United States Department of Commerce was formed, after which the United States Chamber of Commerce turned over to this new governmental agency the sponsorship of the movement, remaining itself in an advisory and supporting position.

The Simplified Practice Division, which has had the assistance of an advisory group, highly representative of industry, and including representation from the United States Chamber of Commerce, adopted a program of action upon the request of a trade group only, meanwhile conducting a wide educational campaign. The first step in this program was a survey of the industry, conducted by the trade, determining the number of current varieties and the demand for each. The results are studied by a simplified practice committee appointed by the industry concerned. A tentative program of elimination is formulated for presentation at a general conference composed not alone of producers and distributors, but also of consumers and neutral engineers. After formal acceptance of the recommendations by a substantial majority of interested groups and individuals, they are published by the department as one of the series of simplified practice recommendations, subject to periodic revision either by another general conference or by a standing joint committee of the industry.

The accompanying chart (Fig. 77) gives an excellent idea of typical reductions in product diversity through the organized movement toward product standardization.

Standardization and simplification of form is a particularly fertile field for trade association action in industries in which the product of one factory becomes the raw material of the next. It is manifestly impossible for a plant manufacturing a primary product, or component, to attempt standardization of product if its customers are continually calling on it for diverse and unusual products to form the raw material for their manufacturing processes. Thus, in the manufacture of wooden wheels, the plants must be governed by the requirements of the vehicle manufacturers; in the manufacture of metal plates for pianos, the requirements of the various piano factories using the product must govern. One manufacturer alone can do little under such conditions. A trade association which interests all its members in this subject establishes standards, and works in conjunction with the trade associations of allied trades can do much.

The use of preferred numbers in standardization. One of the most recent attempts to introduce mathematical precision and logic into standardization is the use of preferred numbers. The system of preferred numbers in standardization sets up a series of values each one of which is greater than the preceding one by a constant percentage. It appears that man prefers a series advancing by a geometric ratio to the arithmetic progression.[4] Eidmann points out the fact that many of the sizes established empirically closely approximate the preferred number series.

[4] See Frank L. Eidmann, *Economic Control of Engineering and Manufacturing*, McGraw-Hill Book Co., Inc., New York, 1931, pp. 268-297.

The Germans have done a good deal of work along this line. The American Standards Association after nearly ten years of study and revision approved a system of preferred numbers in 1936.[5]

The preferred number series takes 1 or 10 as the base and multiplies each successive number in the series by a constant percentage. Where the series is less than 1.0 their values are determined by dividing the series between 1 and 10 by 10, 100, etc. The respective series most commonly used have their constants derived as follows:

$$\text{Series } 5 = \sqrt[5]{10} \text{ or } 1\ 5849$$
$$\text{Series } 10 = \sqrt[10]{10} \text{ or } 1\ 2589$$
$$\text{Series } 20 = \sqrt[20]{10} \text{ or } 1\ 1220$$
$$\text{Series } 40 = \sqrt[40]{10} \text{ or } 1\ 0592$$
$$\text{Series } 80 = \sqrt[80]{10} \text{ or } 1\ 029$$

An inspection of the tabulation above shows that series 5 has 5 uniform steps of approximately 60 per cent between 1 and 10; series 10 has ten steps of approximately 25 per cent; series 20 has twenty steps of approximately 12 per cent; series 40 has forty steps of approximately 6 per cent; and series 80 has eighty steps of approximately 3 per cent.

Many current sizes and dimensions of products have no logical mathematical relationship to each other. Each manufacturer determines his own sizes. Such a situation presents a serious obstacle to standardization. The use of preferred numbers in determining sizes and dimensions facilitates standardization, especially when supported by the trade association of an industry. The advantage of having the trade association support is obvious. Without concerted action, individual manufacturers might well select a different series as a base. While this procedure would establish a logical series for one manufacturer, it would not promote interchangeability.

The costs of switching at once to a preferred series would be prohibitive. In time the change could be economically brought about by introducing new items in the line with the dimensions in keeping with one of the preferred series. Economies can be realized in design and manufacturing in the long run should industry seriously undertake the adoption of the use of preferred numbers as a base for standardization. The most important advantage of preferred numbers will accrue to the purchasers and users in such items as gauges, sizes of materials, over-all dimensions of machines, apparatus, and articles of all kinds, ratings, commercial capacities, speeds, etc. In other words, preferred numbers

[5] See Bernard Lester, *Applied Economics for Engineers*, John Wiley & Sons, Inc., New York, 1939, p. 129.

tend to promote the interchangeability of goods made by different manufacturers.

Effect of simplification upon the worker. A possible limiting factor in the extent to which standardization of product should be carried as a program for industry is the fear of the effect of continued development of standard product upon the worker. Many forward-looking manufacturers have paused to consider whether or not they should adopt a program of product standardization, lest they unwittingly be abetting the degradation of the worker. The point of view of those who oppose product standardization for this reason is that if the product be diversified, the worker tends to be a high-grade, skilled man, capable of diverse work. Such a man is likely to take interest and pride in his work and generally to be a useful citizen. As the product becomes standardized, the worker tends to become a low-grade machine tender, who does simple processes over and over during the day. There is thus likely to develop the type of man with little interest in the job, with practically no pride of accomplishment, and, in general, the type of worker who is easily swayed by movements leading to industrial or social unrest.

There can be no final answer given to these contentions at present because of our limited understanding of the many complexities of social adjustment; there is, however, good reason to question seriously many of the claims regarding the social evils of standardization. Even in extremely diversified production, the workman makes only his small portion of the product day after day. The difference is that he is making his small portion of a number of products rather than of a few. Besides, the skill of the old-type workman has been frequently overestimated as the years roll by; and the newer workman has newer types of skill of which the old workman had none, such as skill in the manipulation of machinery.[6]

The change in type of workman with the standardization of product is a real one. As operations become automatic and repetitive, they can readily be performed by persons of less skill (even in machine operation). There can be no question that the development of product standardization means the future development of automatic machinery to perform the operations in the manufacture of the standard product. But the usual process is not one of degradation of the skilled workman, but rather elevation of the unskilled man into a semi-skilled job. Standardized product means cheaper product. Markets are expanded, luxuries made necessities, and jobs created for many more persons through product standardization.

Mechanization incident to product standardization is but a small

[6] See article, "Skill," by Anna Bezanson, in *Quarterly Journal of Economics,* August, 1922.

step in the progress of the transfer of workers' skill which began with the very beginnings of the Industrial Revolution. Industries producing diversified products must mechanize almost as fully as those producing standard product. The use of process conveyors is not dependent upon the production of but a few sizes of products.

Unknowing people have been heard to inveigh against the "degradation of the worker" in the Ford plant; but they are usually persons who have never been through the plant. It does not take an expert in management practice to see that most of the operators on Ford machines and assembly lines would be in the labor gang were it not for the extent to which their work has become standardized. Unskilled men have been made semi-skilled men at high wages. And what has happened to the skilled man? He has become the tool-maker or the supervisor. The demand for skilled men is greater than the supply, and this demand is also to be found in the vendor plants which sell Ford standardized parts. These skilled men are needed in numbers that would be unthought of, were it not for the huge production demands made possible by the standardized car. And so it is with the whole process of standardization. If all our wants had to be filled by the production methods of 1750, the products would be so expensive that our wants would be nearly as small as those of the people of 1750.

Another answer to the objector to product standardization is the answer to the objection that it kills the worker's initiative. By working on the same work day after day, the worker really can know that job and that machine better than the man who first developed them. He knows enough really to make suggestions that are practical and can be utilized. The worker who, working on the same task day in and day out, cannot find play for his initiative in suggesting improvements, has no initiative. There is a problem in insuring that the worker realizes his relationship to the industrial fabric as a whole, but that is true with division of labor under modern conditions, regardless of standardization.

There is one last answer to the objections. The tasks of a very large share of workers in industries are so constructed that they do not change whether the product be standardized or diversified. To the man working around the dye-vat in the hat factory it makes little difference whether there are hats made of a hundred or of nine colors. His task remains the same, and the technique of his job is not affected.

CHAPTER XVI

DEVELOPMENT OF PROCESSES AND MATERIALS

In no respect does modern manufacturing differ from that of former days more than in the substitution of research for trial and error in process development and the utilization of materials. Scientific research of the highest order has been substituted for the rule-of-thumb development of manufacturing processes that characterized the first one hundred years of the factory era. The consumer of materials, be he a primary or a secondary manufacturer, has at his command the findings of the laboratories of his vendors, the findings of scientific societies, and exchanged information on materials and processes which originated in hundreds of commercial, college, and university laboratories, and in the minds of thousands of scientists in every industrial country on earth. The accumulated body of knowledge which has developed in recent decades is the basis for most of the manufacturing technique of today.

It will be impossible to consider the thousands of types of materials and new processes to be found in modern industry, but a cross-section of recent developments can be given which will indicate from a management point of view the new conditions and possibilities which arise from the changes in materials and process development occurring from year to year.

The determination on a change in manufacturing procedure is usually a major management decision, involving, as it does, large expenditures in new equipment, changes in customer relationships, and at times fundamental changes in the structure of the organization necessary to market and produce the product. Development of product, which we have discussed previously, is linked inseparably with the availability of certain manufacturing processes and the materials of correct characteristics at the right price, as well as the availability of machines to produce the desired quality of goods at a profit.

New processes produce a new type of automobile body. In the late nineteenth century the development of the technique of manufacturing steel rails gave a great impetus to the development of speedier and more reliable railroad transportation. In the early twentieth century the development of structural shapes changed the skylines of our cities. The automobile industry has from its inception relied on the steel industry

to produce for its use certain special steels, as well as a great quantity of steels of heretofore standard specification. Of the recent changes in the processing of steel which have proved the most important in its effects on our manufacturing development, one is the development of the continuous mill for the production of wide sheets and strip (see Fig. 78).

Steelmakers almost overnight found that their methods of producing steel sheets and strip had been made out of date, and that if they desired to participate in that portion of the steel business which was beginning to yield the largest tonnage and at the same time show the greatest profit, it would be necessary for them to install wide, continuous-type mills. These mills, now developed to roll sheets up to 96 inches wide con-

Courtesy "Automotive Industries."

FIG. 78. A Continuous-strip Mill, Inland Steel Co., Indiana Harbor, Ind.

tinuously, that is, with no backward tracking of the material, or transfer to other mechanisms, cost from $6,000,000 to $15,000,000 to install, and their significance to the steel industry, and the users of its product have become equally great. The mill illustrated when built had rolls 76 inches wide, it produces continuous strip from 24 to 26 inches wide, depending upon the gage, and produces plates from $\frac{3}{16}$ to $\frac{1}{2}$ inch thick up to 69 inches wide. Its product, produced in coils, or to length, can equal 2200 tons per day, or approximately 675,000 tons per year, more than ten times the production of the older type hot-sheet mill with eight mills prior to mechanization, and more than twice such a mill after mechanization. Since the automotive industry is the greatest user of the product of such mills, they have largely been located in the states of the Great

Lakes region. The production of such sheets cheaply has led to the development of other processes to handle them economically in the automobile plant, and the availability of such processes has in turn led to the sharp increase in the number of continuous mills, and to an almost insatiable demand for their product. And the whole development of these series of processes has led to the production of the welded all-steel body in the automobile, which made possible the development of bodies of less air-resistance and greater safety, which through their sales appeal, outmoded the designs of prior automobiles and enabled the automobile industry to lead out of the industrial doldrums of the early 1930's.

The possibility of securing wide sheets for body-building purposes revolutionized the processing of bodies in the automobile industry. Die-making machinery became taxed to the utmost to produce the huge dies necessary to form one-piece tops (see Fig. 84, Ch. XVIII). The whole structure of the tool and die industry which had been developed to serve the automotive industry was disturbed by the sudden demands for huge dies of this type. Few die shops were capable of producing such dies, it was difficult at once to secure sufficient equipment from the machine manufacturers, and, in any case, the finances of most of the tool and die shops, usually relatively small companies, would not permit the purchase of such equipment, even if available. Thus much of the die equipment necessary to cope with the new demands was put into the plants of the large automobile manufacturers themselves, and they began producing a greater proportion of their own dies than they had made heretofore.

The press manufacturers were called upon to produce presses of previously unheard of proportions (see Fig. 83, Ch. XVIII) to hold these dies and stamp out body parts which were formerly made up literally of dozens of pieces. The triple-action press illustrated which shapes sedan panels in one operation has three moving slides to carry the dies. It is over 25 feet high and weighs 600,000 pounds, necessitating the construction of a foundation 106 feet deep to solid rock. Similar presses of a size previously unknown caused production problems for both the press manufacturers and the users until complete daily knowledge of their capabilities was developed from experience. But for the development of the other processes described in this sequence, no demand would have been created for such machines.

To fabricate the huge shapes which came out of these presses, another relatively new industrial process was at hand and ready for use—namely, welding. Welding turned the product of the continuous steel mills and the huge presses into something entirely new in the industrial field, a one-piece automobile body, in which the welded seams were literally the strongest parts. (See Fig. 80, Ch. XVIII.) The ingenuity

of the automotive engineer developed for this purpose production fixtures unlike any used prior to that time.

Interrelationships of research and production. Although in this discussion it has been assumed that the development of the continuous rolling mill was the starting factor of this chain of events, this is by no means true; it is the starting factor only in the point of the origin of the material. For instance, the development of the welding process in industry made possible the fabrication of these sheets, and in turn caused a demand to be made upon the steel manufacturers for greater quantity of large sheets, which in turn caused the spread of the continuous mill. Research in many branches of manufacturing, carried on simultaneously, all with the final view of producing manufactured articles which the public will desire to buy in large quantities at low cost, creates a chain of events in which the ends are closed. It is difficult to find either the beginning or the end of the chain. But together they spell tremendous changes in the manner of conducting manufacturing enterprises, tremendous outlays for new materials and equipment, strains on the pocketbooks of those industrial companies least able to bear the burden of the outlays, and changes in the skills demanded of the working man, with consequent changes of occupations and even the location of manufacturing communities.

The electric furnace and its products—steel alloys. The advent of the electric furnace made possible the development of a multitude of alloy steels at commercially possible prices. Relatively great attention will be given to some of these materials because of the manner in which they have affected the competitive situation in a great group of industries, and have swung open the doors of opportunity to the product designer to create new and lasting consumer demands which were not possible prior to the development of these alloys.

For resistance to corrosion, chromium is the alloying element which produces a condition approaching perfection. The long series of "stainless steels" which have been developed resist the corrosive action of many chemical salts and acids as well as the atmosphere. From tableware to stove and sink tops, from automobile trim to whole trains of stainless steel cars, chromium in varying alloy proportions is today making possible products designed from steel which are as attractive after years of use as the day that it leaves the factory, and needs no protective coating.

To add strength to steel, nickel has been the most widely used alloy. It has been combined with chromium where high strength stainless steels were in demand, and where cost could be figured in terms of long-run economy. Where the demand is for ferrous alloys with high resistance to rust and corrosion but also high strength, as in the chemical and

food processing industries, nickel steels are important factors. Nickel-manganese cast steels are important in structural parts of railroad cars, tractors, and power shovels, where ultimate strength is the important consideration. Common gray iron, with nickel alloy has also proved to be a successful, and, under many conditions, an economically proper material, fully able to compete with steel castings under conditions where stresses are not too great.

For many years molybdenum was added to steels which required strength, hardness or toughness at elevated temperatures of operation. It is an alloy which imparts superior high-temperature properties to numerous working parts. With the clearer definition through the years of the results of proper manufacture of steels in the first instance, and heat-treating of steels after manufacture, there has been a constant tendency to reduce the percentage of alloys in the steels, and hence increase the range of their economic usefulness. With this attention to the problems relating to the action of heat on metals has come a knowledge of the greater usefulness of molybdenum as an alloy. Plain carbon-molybdenum steel has proved most successful for deep-drawing steels, and steels for high temperature service. Chrome-nickel-molybdenum steel has now become a common alloy. This steel, with a high carbon content, is to be found in large forgings of many types, and in high-temperature forging dies.

Innumerable other alloys and combinations of alloys are utilized to give particular properties to steels for specific economic uses. The illustrations given suffice to indicate the manner in which, again, the demand of industry for a material results in research into material properties which brings as its result a product more usable, more reliable, easier processed, or perhaps an entirely new series of industrial and economic relationships. Nowhere has this been more clearly demonstrated than in the development of materials for metal-cutting tools and dies.

Tools and dies. The manufacture of steel for tools and dies has long been one section of the steel industry to which the most research has been devoted, and its economic significance has been possibly the most important of that of any section of the industry, particularly in relation to displacement of labor by machines, and in its effect on the machinery industry, in causing significant changes in the character and design of the machinery in order to take full advantage of developments in the capacity to machine to be found in newer tool steels. It was the long and careful research of Frederick W. Taylor and J. Maunsel White just prior to 1900 at the Bethlehem Steel Company which resulted in the development of "high-speed steel," the first significant improvement on older carbon steels used for cutting metals. It was not only the alloy composition of this steel, but the carefully developed method of heat

treating it which made it stand apart from all other metal-cutting materials, and caused production increases of 400 to 500 per cent with the same machines and equipment. Increased production was aided by the proper utilization of the fast-developing body of knowledge of how to sharpen these tools (see Chapter XVIII). This high-speed steel had the ability to stand up when run at speeds that heated the tool red-hot.

During the decade between 1920 and 1930 much of the development work was done which produced a diverse and special-purpose series of tool steels. One of the first special steels to be introduced, and still utilized on a large scale, "Haynes Stellite," was a cobalt-chromium-tungsten alloy, which, like high-speed steel, maintained its properties at red-heat. It machined at high speeds cast iron, malleable iron, and semi-steel, and could be profitably used on certain grades of steel. Toward the close of the decade there were developed first in Germany, and later in the United States a number of tungsten-carbide steels, of which the best known is "Carboloy." These new steels at first had limited applications, giving extremely rapid speeds of cut on light feeds for continuous cuts, as on lathes, but cracking or shattering on other types of cutting operations, and failing on heavy work. Gradual development soon obviated most of these difficulties, and this series of tool steels soon necessitated the virtual redesign of numerous machine tools in order to provide for the stresses which their high speeds set up. Because of the high value of the material, these tools consist of small tips of alloy welded to steel shanks. (See Fig. 92, Ch. XVIII.)

Mr. Philip E. Bliss, President, Warner & Swasey Co., manufacturers of machine tools, has said,[1] "With the new tungsten carbide tools, a turret lathe of the same size as one built ten years ago is capable of removing twice as many cubic inches of metal in the same period of time. . . . A factory faced with the problem of doubling its output may, therefore . . . instead of doubling its floor space and equipment, keep its present floor space and replace its present metal-working equipment with machines of twice the speed and twice the productivity. . . . The result may be a new trend in factory building and factory rehabilitation—a trend in which compactness of operations and maximum productivity per unit of space may be the outstanding characteristics."

For dies, special alloy tool steels have been developed which have increased productivity in equivalent ratio with the new cutting steels, and at the same time have permitted longer operation of the presses on high-production runs without the necessary down time to change dies. Chromium-vanadium alloys have proved helpful in this development. So have the cobalt-chromium-tungsten alloys. Inasmuch as whole dies of any of these materials would be prohibitive in cost, once again welding

has made a process commercially possible. The alloy is welded to the wearing parts of the die, or placed in the die in the form of inserts. At this point it may also be mentioned that similar wearing surfaces on many types of machinery and equipment are today protected by coatings, edges, or points of alloys in order to resist wear and abrasion. Among the products so protected may be mentioned automobile valve seats, plow shares, pug mill knives, clam shell bucket lips, shredder knives in paper mills, and steam valves.

Special production tools. Coupled with new machine capacities and new productive capabilities of the alloy tool steels has been the development of tool design to produce special cutting tools which when applied to the problems of a particular job will result in tremendous savings. Space will permit the inclusion of only one detailed example of this, but this will indicate how the calculations incident to any long-run production job may result in special tooling being the most economical answer to the production problem. The machining of a clutch housing will be taken as the example. The former method of operation included:

1. Mill the lugs for locating points.
2. Rough grind the under surface of the housing.
3. Machine the interior of the housing in five separate machine operations.

The present method is to utilize one specially designed cutter, which because it combines all the machining operations eliminates the necessity for locating points, and hence the milling process. Because of the greater capacity of the special tool, the rough grinding process has been reduced from 6 minutes to 1.8 minutes per piece. The five separate machine operations have of course been replaced by the one that utilizes the special cutter. The former operations took 22 minutes in machine time alone, without considering handling time between operations, or the necessary preparatory and planning steps. The job is now done with one grinding operation of 1.8 minutes and one cutting operation taking 6.32 minutes, a clear saving of 13.88 minutes per piece in machine time.

Heat treating and its significance. Developments in the heat treating of metals have coincided with developments of alloys to produce materials which are easily machinable, the final product having properties quite different from the properties of the metal at the time that it is machined. Certain desirable conditions and properties are also developed in metal by heat treating which have no relation to its workability. Heat treating includes quenching by immersion in liquids or gases; hardening, or heating and quenching from the critical temperature where the molecules of metal are rearranged; annealing, or heating and then permitting slow cooling of the metal; case hardening, or heating the metal in contact with carbon, so that some of it will be absorbed

by the surface of the metal, and then hardening further; and cyaniding, or heating the metal in contact with a cyanide salt, followed by quenching. Effective heat-treating in a commercial manner has become possible through the development of temperature control devices which provide proper temperature relationships throughout the heating cycle or in the quenching bath. These instruments have come to be the key to successful heat-treating. Distortion in hardening has come to be controlled through a more thorough understanding of the heat-treating process and a consequent design of parts to prevent such distortion. Research into heat-treating problems has proved to be particularly helpful in correcting material conditions which reach back into previous processes, and at times into steel-making itself.

Utilization of non-ferrous metals. Commonplace methods of utilizing non-ferrous metals in industrial processes need no further consideration here than would other basic commodities, such as cotton, wood, or rubber. Aluminum, and copper, with its commoner alloys, brass and bronze have come to be an integral part of the materials for our industries for many years, although it was 1886 before aluminum was first reduced by the electrolytic process and many years of experimentation followed before its price permitted its general use in those parts for which it was best fitted. Magnesium, a metal even lighter than aluminum, has begun to be used on a considerable scale in materials where lightness is an all-important factor, as in the airplane industry. Aluminum, often also used because of its lightness, has been used on a large scale because of its excellent properties for conducting heat, as in the manufacture of kitchen utensils, and for cylinder heads in the automotive industry, to avoid the formation of hot spots above the cylinders in high compression engines. Aluminum has come to be extensively used in die castings, and in such use particularly, nickel is frequently added as a strength-imparting alloy.

Monel metal, an alloy composed of approximately two-thirds nickel, slightly over one-quarter copper, with slight portions of other metals, has become a household word in recent years because of its extensive use in kitchen equipment, wherever resistance to rust and stains is an important factor. Particularly in large kitchens, such as those of hotels and restaurants, has this metal come to be used for finishing tops of equipment. Its use has been somewhat retarded because of its relatively high price due to the large percentage of nickel which it contains, and the concurrent rise of the stainless steels.

Die-casting. One of the newer processes of industry, having as a basis utilization in new ways of some of the older metals as well as some of the newer metals, is die-casting. Decorative effects which can be produced cheaply by die casting have caused this process to advance

rapidly in use as consumer demands have come to require better-looking as well as more useful products. Both zinc and aluminum alloys can be readily die-cast. While some resistance to stress can be developed in a die casting through the addition of such an alloy as nickel, as has just been indicated, nevertheless in the main it is the smooth finish resulting from the process, eliminating any need for machining, which has caused its application in large measure to intricate designs, intended for decorative effect. (See Fig. 82, Ch. XVIII.)

A feature peculiar to die castings is that it permits making as a single unit a product or component which otherwise would have had to be composed of a number of individual units, joined by welding or some fastening method. Inasmuch as the die-casting operation in its simplest terms involves only flowing metal into a die under pressure, and maintaining it there the time required for it to solidify, the most modern die-casting machines are almost wholly automatic in their operation, only requiring the worker to remove the finished piece from the die, thereby further increasing the utility of this process, as costs are reduced. Elaborate designs may require the operator to insert cores or steel parts. The design and composition of the steel die is easily seen to be the heart of this operation, and the intricacy of the finished product is limited only by the ability of the diemakers to produce practical dies. Die-castings find some competition from molded plastics, an important new industrial material referred to later in this chapter, but are also used to some extent in conjunction with plastics, as on grocery scales, where the die casting may form the structural part of the device, and the plastic the molded casing. This combination of two relatively new materials replaces painted gray-iron castings and strikingly illustrates how the changes in available substitute materials may materially affect the prosperity of both the maker and the user of industrial materials.

Welding. Throughout this discussion of important changes in the processes and materials of industry, frequent reference has been made to welding, from the discussion of the chain of new processes which has brought with it the new all-steel automobile body, to the discussion of new types of cutting tools. Welding is probably the most important single process of industry that has been developed during the twentieth century. Its ramifications reach into every industry, and its products are to be found around us everywhere. Its progress is the perfect example of the practical results achieved through theoretical research. In welding, metals are united by one of two general methods, (1) plastic processes, in which pressure and heat produce the weld, and (2) fusion processes, in which the weld is made through the application of heat to the metal without pressure.

From a practical standpoint most plastic welding done in manufactur-

ing today is resistance welding, that is, the heat is produced by the passage of electric current through the parts to be joined. It is referred to by a variety of designations, dependent upon variations of the process employed, some of which are butt, flash, spot, seam, and shot welding. Butt and flash welding are used to join the ends or sides of tubes, bars, sheets, or similar material in raw or partly finished condition. In butt welding, the pieces are pressed together, an electric current is passed from one piece to the other, which causes a slight melting at the ends, and a resulting union of the two pieces. In flash welding, particularly used for welding sheets and stamped parts, the pieces are drawn apart slightly after the current has been applied, the resulting arc fusing the surfaces to be joined. Pressure is then applied to complete the union. Many specialized machines have been developed to produce welded parts by the flash welding process. (See Fig. 81, Ch. XVIII.) Spot welding utilizes welding equipment with two electrodes on opposite sides of the pieces to be joined. As current flows through the pieces, it heats the area immediately between the electrodes to welding temperatures, the pieces being joined by pressure applied by the machine through the electrodes. It is this process which is used to weld small stamped parts to large ones, for instance, bolt holders to enameling sheets in stove manufacture. It is a very rapid operation, for if proper fixtures are supplied, dozens of spot welds can be made in a minute. Seam welding is a modification of spot welding, where continuous seams are desired between the metals to be fused, the electrodes being wheels that roll over the surface of the metal being welded. A modification of the seam-welding process is used in automatic welding machines which are employed in the manufacture of welded steel pipe, made from coiled strip steel, run over a series of rollers, thereby bent into pipe form, and then welded. Shot welding is a specialized type of resistance welding developed and patented by one large manufacturer of welded equipment, the E. G. Budd Manufacturing Company of Philadelphia.

Fusion processes of welding most used are the electric arc and the oxyacetylene methods. In addition to production work, these processes are used for repair work on machines and equipment through the use of portable apparatus. In the electric arc process, either metal-arc or carbon-arc methods may be utilized. In metal-arc welding, the current passes from a metal rod to the work. The heat of the arc causes melting of the edges of the work and the end of the rod, molten metal from which is deposited on the work, causing the fusion. In the carbon-arc process, an arc is formed between a carbon electrode and the work, metal being deposited upon the work from a welding rod held in the arc. Large plates, large pipes, and tanks are welded mainly by use of the electric arc process. Oxyacetylene welding utilizes a flame produced by burning

a mixture of oxygen and acetylene in a blowpipe. This flame can be utilized to combine a wide variety of metals of different grades and characteristics. At times a welding rod which melts at lower points than the metals being fused is advantageous in welding several metals of diverse physical characteristics. The oxyacetylene welding flame can be made to have an oxidizing effect by increasing, or a reducing effect by decreasing the amount of oxygen in relation to the acetylene. This is most valuable in welding metals of varying characteristics, the latter particularly in welding rolled sections to castings.

The development of surface finishes, together with the improvement in steel stamping processes, has permitted welding to be the process to give to the industrial designer, the manufacturer, and the consumer the modern products with the pleasing streamline effects, for which rounded corners and the absence of seams are most important.

Electric control devices. Back of the full-automatic and semi- automatic machines of today must be the devices which give them their automaticity. Some of this is attained through perfection of machine design, including cam arrangement, and some has been achieved through the use of hydraulic and pneumatic means, but by far the largest part has come from electric controls. The machines are ordinarily actuated by the electric motors applied to them, and these in turn by intricate controls, timed to provide means for bringing into play each function of the machine at just the right time in relation to every other function. The solenoid coil forms the basis of operation of many of these control devices. Other electrical developments which have come to have general industrial significance are the photo-electric cell and the vacuum-tube.[2] The first is of particular importance in controlling colors of product, while the latter has been utilized in many types of control such as recording the moisture content in the manufacture of paper. For instance, a rayon ribbon stretched across a tube and held just above the paper going through the machine gets longer or shorter depending upon the moisture in the paper. A radio measuring device in the tube transmits these changes in length to a meter, which can readily be read by the machine operator, who then makes any indicated adjustments to bring his moisture content to normal.

Chemical materials or products. This chapter would not be complete without a brief mention of some of the newer materials being used in industry that have grown out of chemical research. Possibly the most popular of these materials are the plastics. Plastics are marketed under many trade names such as bakelite, textolite, cetec, durez, tennite, etc. The properties of the various plastics are many and may be varied to

[2] See Keith Henney, *Electron Tubes in Industry*, McGraw-Hill Book Co., New York, 1937, p. 498.

meet different situations. Plastics as a group may be molded or machined to meet many requirements. They are used extensively in the manufacture of radio cabinets, electrical controls, automobile steering wheels, gear shift knobs, silent gears, etc. Almost any color is available in plastics. They easily take a high finish and usually have a high resistance to moisture and many acids. They usually possess a high ratio of strength to weight and may be produced to provide a high degree of resilience to absorb mechanical shocks. It is highly probable that the use of plastics will increase. It is not an impossibility to build an automobile body out of plastics.

Duprene, neoprene, or synthetic rubber is another product that the E. I. DuPont de Nemours & Co., Inc. has given to industry. Duprene must be vulcanized the same as natural rubber, but it does have some characteristics that are said to be superior for certain purposes to rubber itself. For instance, some chemicals will attack products that are made from natural rubber; however, when duprene is used they are impervious to attack. Oils and greases are said to have much less deteriorating effect on products made from duprene than natural rubber.

Both rayon and nylon are synthetic products that bid fair to exert a profound influence upon the field of fabrics. Rayon has already established itself while nylon is just arriving. Rayon has been successfully used in automobile tires. It is highly probable that nylon may be even better than rayon for industrial use if the claims being made for it are borne out in service.

The future of synthetic products seems to be bright. They have already made a real contribution to industrial processes and the surface has scarcely been scratched in terms of their possibilities.

CHAPTER XVII

STANDARDS OF MATERIALS USED IN PRODUCTION

The meaning and value of standards in management. Before discussing the various types of standards, it will be desirable to define clearly the word "standard." "Standard," under modern management, means a carefully thought-out method of performing a task, or carefully drawn specifications covering some phase of the business. These specifications may cover working conditions, equipment, some method of performing a job, or some article of material or product.[1] Standardization does not imply that perfection has been reached. Nevertheless, after conditions or methods have become standardized, there usually follows a constant attempt to raise the standards and to move them toward perfection. The standard is merely the best method, condition, or specification that can be devised at the time, taking into account all the limiting factors such as price range, available equipment, material used, etc. Improvements in standards are usually desired and adopted whenever they are found. Although there is nothing in the idea of standardization that precludes change, nevertheless standardization protects from changes that are not in the direction of improvement.

Standardization of product may or may not necessitate standardization of operations. It is possible, although not likely, that a standardized product may be made from unstandard material on unstandard machines by diversified methods. It is more likely that product standardization will be the first step toward complete standardization of operations.

A standard is a base line for management. The setting of standards thus becomes one of the fundamental tasks in organizing a business for operation. The value of standards as base lines are fourfold: (1) They create a foundation upon which other steps of good management may be built. (2) The setting of them of itself causes a careful investigation to be made into all phases of the business. Without such investigation standards cannot be intelligently set. (3) They tend to aid routine operation of the business, and thus the development of a system and the

[1] Specifications are discussed in greater detail in Chapter XL, "Purchasing Department Operation," and Chapter XXXII, "Utilizing Time-Study Data."

application of the exception principle of management. (4) They reduce costs of operation in a way peculiar to themselves, thus making possible reduced costs to the ultimate consumer, as well as increasing the profits of the business.

Frederick W. Taylor said: [2] "It was in the course of making a series of experiments with various air-hardening tool steels with a view to adopting a standard for the Bethlehem works, that Mr. J. Maunsel White, together with the writer, discovered the Taylor-White process of treating tool steel, which marks a distinct improvement in the art. The fact that this improvement was made, not by the manufacturers of tool steel, but in the course of the adoption of standards, shows both the necessity and fruitfulness of methodical and careful investigation in the choice of much neglected details. . . . The economy to be gained through the adoption of uniform standards is hardly realized at all by the managers of this country."

The conditions in American industry with regard to standardization have improved since Taylor wrote the above. This is particularly true in some branches of the metal-cutting industry. Much of the improvement can be laid directly, and much more, indirectly, to Taylor's work. In many other industries, however, the setting and maintaining of standards have scarcely begun, and there is everywhere much opportunity for study and improvement in conditions.

The discussion of factory working conditions in previous pages brought out constantly the necessity for the development of standards of lighting, of movement of material, of air conditions, and of other similar phases of the plant itself. Analysis of these points will show that in attempting to better these conditions, in reality standards are being set. The discussion of simplification has focused attention mainly on one phase of standardization, namely, the elimination of useless duplication of product.

Standard material. Analysis of the problems of material standardization will indicate the factors involved in applying standards to operations, as contrasted with organization or working conditions. It is impossible for production problems to be readily solved if the material that is being worked upon is not standard, or if the composition of the material is not known definitely. Naturally, it is not necessary that the best material be purchased. This would force all product to be high-grade, and afford no goods for those with low purchasing power. Therefore, standardization of materials takes the form of type standardization, regardless of whether the type be the most costly, but mindful of manufacturing problems.

[2] Frederick W. Taylor, *Shop Management,* Harper and Bros, New York, 1919, p. 124.

An outstanding characteristic of the use of standard material is the factor of reliability or certainty. Absolute reliability or certainty is not practical, but reasonable manufacturing reliability is both practical and economical. The product engineer specifies certain qualities to be desired in the material used and can predict the performance of his product with commercial assurance.

The standardization of raw materials directly affects the operation of several branches of any manufacturing enterprise: (1) the product engineering department, (2) the materials engineer, (3) the purchasing department, (4) the methods department, (5) the production control department, (6) the time-study department, (7) the actual manufacturing departments, (8) the cost department, (9) the salvage department, and (10) the inspection department.

The product engineer's interest in materials. The tire design engineer may specify a long staple sea island cotton of a certain specification and rely implicitly upon its strength. The tensile strength of this fabric of a given specification has been established as a result of literally thousands of breaking tests in the laboratory. Should the fabric not be of the required standard, because of a different twist, shorter staple, or because of having been exposed to some chemical, the unaided eye might readily fail to detect the difference; however, the strength would be reduced and the tire design engineer's careful work would be largely in vain. It is because of such situations that materials are tested at great expense. As a matter of fact, in modern tire construction the design engineer realizes that his work is largely futile unless standardized materials are used. The same principle holds for machine construction, building construction where strength is a factor, and in many other types of products.

The materials engineer. The materials engineer is a relatively new functional officer in industry. He may be attached to the product engineering department, the purchasing department, the research department, etc. He usually would have a dual function—one to be on the alert for new materials that may be substituted for materials now in use either as a matter of reducing costs or improving the product, and the other to check the quality and use of present materials. Where the second function is of prime consideration he may be attached to the inspection department or the purchasing department. Should he be attached to the inspection department his influence will be relatively slight; however, should he be attached to the purchasing department he will act as an adviser not only to the purchasing department but to other departments, especially with respect to new materials. New products are constantly being marketed, especially in the field of chemistry and plastics. The materials engineer may well be in a

position to suggest, to the product engineer and others, substitute materials that are better adapted to the requirements of the product or manufacturing processes.

The purchasing department. If the materials bought are standard, the purchasing department is better able to keep abreast of market conditions, and to place large orders and thereby receive lower prices and larger discounts. It is also better able to keep in touch with the demands of the factory for raw material, and hence to lessen the likelihood of a partial shutdown because certain raw material is not available. In the purchase of raw material it is essential for the purchasing department to keep in mind that it sometimes costs much more to work up a poor grade than a good grade of material. As a result of research on the part of individual corporations, trade associations, and the federal government, a great mass of data has been accumulated on various materials. Much of this has been formulated into recognized standards which are available to the purchasing department. These standards for materials simplify the work required of the purchasing agent. As a matter of fact, purchasing agents have taken an active part in establishing standards for direct materials used in the product as well as supplies.

The methods department. After the design department has approved a product, it is usually turned over to the methods department for study as to its practicality in manufacture. It is not at all infrequent for the design to be modified at the suggestion of the methods department to simplify its production or to make use of standard material already in use in the plant. The methods department is interested not only in standard material as a means of simplifying operations, but also in making use of available equipment. A good illustration of the interest of the methods department in standards of material is the case of some of the deep fender draws made necessary by present automobile design. Ten years ago it would have been difficult to produce these fenders; the advance of metallurgical science, however, has developed standards that make these fenders relatively easy to produce.

The manufacturing department. As long as the materials come to the operating units according to specifications, things tend to run along smoothly. On the other hand, when materials do not run true to form, much additional labor is required. When the sheet metal draws properly for the fenders, the metal finishers can keep up with their end of the work and are usually satisfied with their earnings. When 10 per cent additional labor is required because of ripples in the metal, the metal finishers cannot meet standard and production falls behind schedule. The same situation applies to all other operations. Any

irregularity below standard usually requires additional labor and not infrequently increases the normal scrap from operations.

The time-study department. Standardization is essential to time study that is to be fruitful. As a matter of fact, standardized operations must be adopted before time values can be established. Standardized operations can be attained only when both material and machines are standardized at least to a workable degree. When standards are set for a given material, they are presumed to hold until the method is changed. If the material falls below the standard set, the method has to be changed, which immediately destroys the standard. This breeds ill will on the part of the employees and tends to set at nought the efforts of the time-study men. There is no agency in manufacturing more vitally interested in establishing and maintaining workable standards for material than the time-study department.

Production control department. Even though the plant may be a job order plant, making products that are not standard in their entirety, nevertheless a large part of the work is standard. Were it not so, production control would be impractical. By having the desired material available when needed, and by following carefully a logical sequence of operations, production control reduces the required inventory of raw materials required to be kept on hand, reduces the inventory of work in process, increases total output, and makes possible the making of promised shipping dates a reality. Adequate materials of the proper specifications are a vital necessity to proper production control.

The cost department.[3] Standardized materials and processes are an integral part of standard costs so widely used in industry today. While it would probably be an exaggeration to say that standard costs could not be used unless there be accurate maintenance of material standards, it would be true to state that the use of standard costs under such a situation would be largely in vain. Standard costs are built upon a theoretically desired standard that is capable of attainment under practical operating conditions. In turn, standard costs aid in maintaining the standard set-up. Any deviation from the standard of materials used will tend to show a deviation from the standard costs. If the standards are proper all such deviations in materials will tend to increase costs, which in the long run will either increase the selling price or reduce profits.

The inspection department and material standards. The prime interest of the inspection department is the measuring of quality against an established standard. The inspection department plays an important role in quality maintenance, even though it is the manufacturing department that is basically responsible for quality. This department tests

[3] See Chapter XXXVIII for a discussion of standard costs as a medium of control.

incoming materials and these same materials as they are progressively processed throughout the plant. Quality can be secured in the absence of standard materials, but as stated above, the cost of maintaining this desired quality in the finished product is high.

Large companies maintain their own testing laboratories and staffs of scientists who develop material standards as well as new products. The electrical industry has come to be known as spending more than any other in this type of research; companies such as the General Electric Company spend millions of dollars a year on such tests. The age of national advertising has forced manufacturing companies to stand back of their product for many years, because sales years hence are dependent upon the lasting qualities of the product sold today.

Service tests are often necessary in addition to laboratory tests. Particularly in industries in which standard grades are unknown to the trade, it may be wise to submit a sample of a prospective purchase to actual service conditions in the plant, and to measure the qualities of the material agreed to between the vendor and the user on the basis of this run.

U. S. Bureau of Standards tests. The United States Bureau of Standards makes about 200,000 tests of materials yearly, many on direct request of manufacturers. In order to promote wide use of the results of these tests, this Bureau has adopted a so-called "certification plan." The Bureau compiles lists of manufacturers who have expressed their desire to supply material in accordance with certain specifications, and who are willing to certify to the purchaser that the material thus supplied is guaranteed to comply with the requirements and tests of these specifications. This is an extension of the service which the Bureau of Standards has furnished for some years to government departments. A purchase of materials which is supposed to meet such specifications, by a company without its own laboratory, may now be checked easily by submission to a commercial testing laboratory, for the specification is standard. To the extent that the certification plan results in the standardization of commodities, its benefits are felt by all material users, whether or not they directly use the certified specifications. For some years some commodities, as for instance lumber, have been marked with the standard grade of an association, as the American Lumber Standards. It is reasonable to expect that the "certification plan" of the Bureau of Standards will increase in importance in industrial usage.

The American Engineering Standards Committee. This committee, with offices in New York, is a creation of the several technical societies, such as The American Society of Mechanical Engineers, The American Society for Testing Materials, and the Society of Automotive Engi-

neers; a number of trade associations, such as the National Electric Light Association, the American Gas Association, and the American Railway Association; and a number of other groups interested in industrial standards, such as the National Safety Council, and the Bureau of Casualty and Surety Underwriters.

The purpose of the American Engineering Standards Committee is to develop standards for industry through mutual action. When a particular type of standard is to be developed, a sub-committee is formed, with representation from all those interested in the proposed standard. Among those who receive such representation are the engineering society interested, manufacturers of the article, users of the article, and labor. When this sectional committee makes its final report, this is reviewed by the executive committee of the American Engineering Standards Committee, and if finally approved is adopted as American standard.

Material standards change. As new techniques develop new characteristics in materials, the specifications are changed to incorporate these advances. The National Bureau of Standards has had a wide experience in observing specification change and has listed the following qualities as desirable for specifications: [4]

1. They must be definite in character and free from clauses which require an expression of opinion by the inspector.
2. They must be limited to the essential qualities of the product or material under consideration. The specification of unessential qualities may increase the cost of the product and certainly increases the time required for testing.
3. The qualities specified must be capable of measurement.
4. The specifications must be supported by definite test methods in order to avoid quibbling about the methods of testing.

Item 2 above is particularly significant in terms of taking advantage of changes in the material available. Standards of material are designed to aid the progress of man in satisfying his wants and not to hinder his progress. Inflexible rigidities in materials as in other things tend to thwart advancement.

[4] Adapted from Services of the National Bureau of Standards to the Consumer (not dated), p 5.

CHAPTER XVIII

MACHINES AND EQUIPMENT

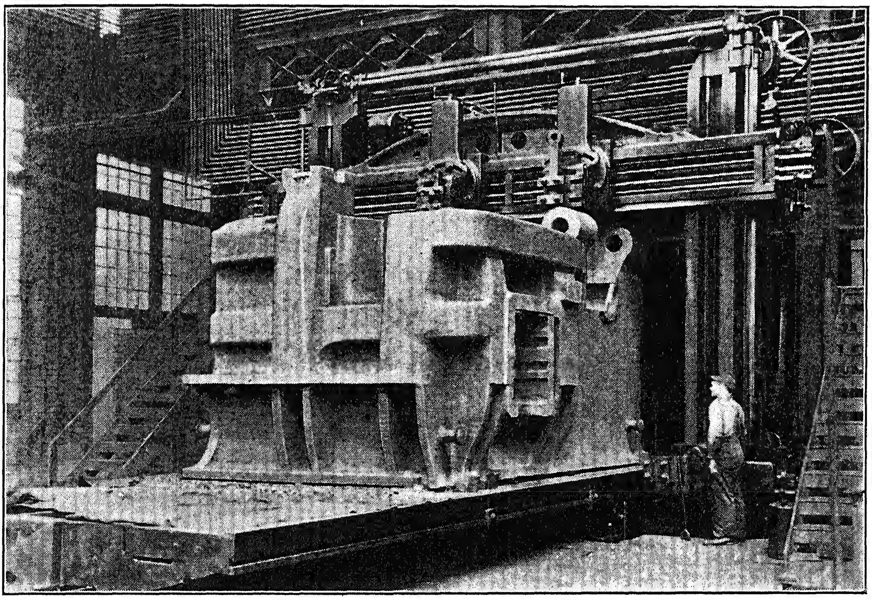
General discussion. The history of man's struggle to extend his domain over the realm of the material world is a romantic one. Our present era has been successively called the *machine age*, the *age of electricity*, and the *chemical age*. Each of these names characterizes a phase of the material culture that seemingly was in the ascendency at the time of its use. There is a great measure of truth in each of them, although basically, the *machine age* is more truly expressive of the real situation than either of the others. Both the development of electricity and the chemical marvels of the present rest solidly upon man's ability to multiply his efforts through the utilization of the machine.

Watt clearly demonstrated the principle of the steam engine several years before he was able to construct a producing machine for the very simple reason that there were no machines sufficiently accurate with which to make either the cylinder or the piston. It had to await the development of a metal turning lathe before the steam engine could become a practicality. The same holds true today. The marvels of electricity are dependent upon the ability to make the motor generators that generate the current.

Machine tools. Back of the so-called production tools used in our great factories are a group of manufacturers known as the machine tool builders. These manufacturers produce the machines that are used in making the production tools and dies used in manufacturing the products that are sold in quantities to the buying public. The basic tools used in making the production machines are the lathe, shaper, planer, drill press, and more recently the precision grinder. It is also true that these same machines are used with special adaptation for production purposes, but for the present we are interested in the more accurate machines used by the machine tool builders. These manufacturers and their workmen are master-craftsmen working with close tolerance and great ingenuity. The great Allis-Chalmers Manufacturing Company at Milwaukee produces gigantic production equipment used in industry. (See Fig. 79.) Their work would be impossible were it not for the marvelous machine tools with which they work.

The plant as a machine. As was pointed out in the chapter on the "Factory Building and Plant Layout," in mass production the plant

itself is frequently a giant machine made up of a series of synchronized individual machines. The A. O. Smith Corporation automobile frame plant of Milwaukee is probably the best illustration of the plant as a semi-automatic machine. Strip steel is unloaded from the freight cars by machinery, inspected for gauge, width, and length by machinery, and progresses through the many operations with the hand of man seldom touching it. Even the thousands of rivets used daily are inserted in their holes automatically through pneumatic tubes. The rivets are fed into the pneumatic tubes automatically through a hopper. As the frame



Courtesy "Steel."

FIG. 79. Casting Weighing 152,000 Pounds for the Bed of an Upsetting Forging Machine being machined on a Planer at the Allis-Chalmers Manufacturing Co., Milwaukee, Wis.

moves from station to station along the conveyor, the riveting machine moves into position and clinches the rivet and again moves back out of the way until the next frame comes into position, when the riveting machine again repeats the cycle. It is truly a plant laid out as an automatic machine.

Utilizing standard equipment. Equipment must be thought of as everything, except material, with which the worker is provided to aid him in the performance of his task. As has been indicated, the building itself is a most important phase of equipment, but usually it is not referred to as equipment. Equipment ordinarily includes all apparatus

assigned to production centers at which employees work, including workbenches or machines, and all tools, either separate from the machines, or fitted into them as particular jobs are to be done. As with materials, standardization of equipment is important, not only as a ground work for setting rates, but because of the economies of utilizing equipment suited to its tasks.

Standardization of equipment tends very definitely to reduce maintenance costs in that the maintenance workmen become more familiar with the peculiarities of standardized machines and the inventory of repair parts that must be carried for emergencies is reduced. This inventory factor is no small item. It works itself out in two ways. In the first place, if the machines are too varied the keeping of repair parts becomes so complicated and costly that an adequate supply of parts will seldom be kept. When this situation prevails, breakdowns become very costly since production will be tied up unnecessarily or overtime has to be paid. In the second place if adequate repair parts are kept, the total number is much greater for varied machines than where the machines are standardized.

Not only are inventories of repair parts reduced and maintenance kept to a minimum by standardizing equipment, but actual economies of production operation also follow. Workmen become accustomed to working with a given type of machine and can be transferred from one to another with relatively little loss in efficiency where the machines are standardized. This contributes to flexibility in the use of manpower.

It should not be inferred that standardization of equipment requires all machines of the same general type to be alike. It does mean that as far as practicable all machines performing the same identical operation should be alike. A six-inch production lathe will be used where the work requires this size and a twelve-inch lathe where the work requires that size. Occasionally a six-inch operation may be performed on a twelve-inch lathe when the other machines are in use. The matter of balance in the selection of equipment is not always an easy one. A department may be in perfect balance as to sizes and types of machines at one time and then be out of balance a year later when conditions have changed.

Working toward standardized equipment. Industry is constantly undergoing change. Improvements are continually being made in both the machine tools and special purpose production machines. When a manufacturer decides to standardize his equipment he may be faced with the problem of what to do with his present equipment. The economies occasionally will justify standardization even at the cost of selling his old equipment at whatever price it will bring. Often this is not the case, yet it does not preclude a definite decision to standardize.

Instead of replacing the present with the type decided upon for standardization at one time, the desired equipment will be installed gradually as the older equipment is worn out. It may take some time to complete the standardizing process but it is a goal toward which good management strives.

Special purpose equipment vs. standard machines. Standard machines such as the lathe, grinder, planer, shaper, and drill press have certain very definite advantages over special purpose machines. Standard in the sense that it is being used here refers to the general purpose machine. (It is possible to standardize the production of special purpose machines.) A few of the advantages of the standard or general purpose machines are as follows:

1. Increased flexibility in the range of the work that can be done.
2. Decreased initial investment in equipment. The standard machines usually cost less largely because they are produced in larger quantities and the cost of engineering is spread over a larger number of machines.
3. Possible decreased number of machines required to meet production needs, arising from the increased flexibility.
4. More capable of meeting requirements of changes in design of the product or even a complete change in the nature of the product.
5. Easier to maintain balance in the equipment required and less dependent upon mass production.
6. Maintenance less expensive in that repair parts cost less and require less skill to install.

In the case of special purpose equipment certain conditions must prevail in order to justify the expenditures necessary for installation. These conditions are:

1. It is necessary that the market for the product be large enough to absorb the output of the special purpose equipment.
2. Product must be well standardized to make use of the special production machines. (See Fig. 80.)
3. Style and technical changes should be infrequent or volume sufficiently large to amortize the cost of the equipment in a short time, as is the case in the automobile industry. (See Fig. 81.)
4. It is highly desirable that seasonal and cyclical variations in production be reasonably low.
5. Sufficient funds must be available to absorb the high fixed capital investment.

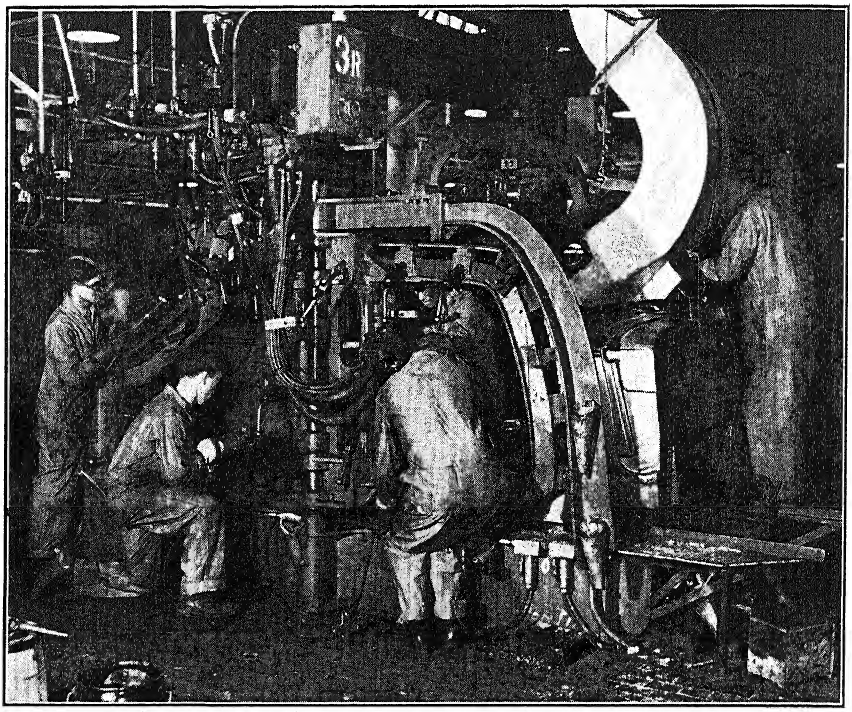
Where most of the foregoing conditions prevail, special-purpose equipment has many advantages, a few of which are as follows:

1. The quality of the product tends to be more uniform.
2. Inspection costs are reduced.

3. A semi-skilled operator usually can be substituted for a more highly skilled man.

4. Output per unit of time is greatly increased, thus reducing the direct labor costs.

5. Factory floor space is usually less for the same volume of production.



Courtesy "Automotive Industries."

FIG. 80. A "Set-up Buck," where five component body parts are welded into a single unit. (Specialized production fixtures have attained a maximum of complexity and simplicity of operation in the automotive industry. Note the suction pipes drawing fumes from the interior as the welding progresses.) Pontiac Motor Co., Pontiac, Mich.

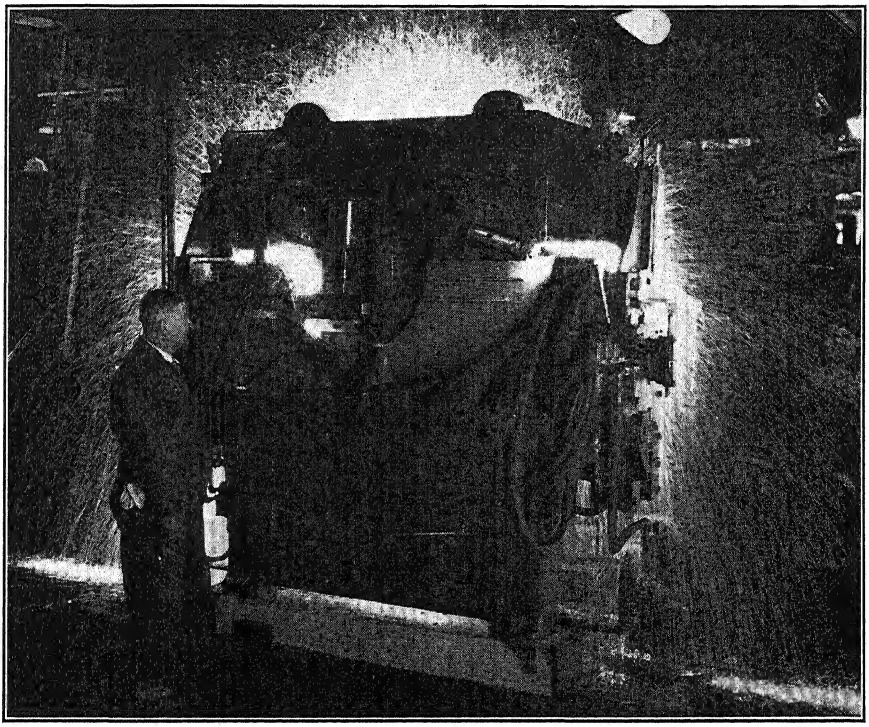
6. A reciprocal relationship tends to exist between labor specialization, process specialization, and machine specialization.

7. Unit costs tend to be reduced.

The negative side of the advantages of standard purpose production equipment are in substance the disadvantages of special purpose machines, such as: less flexibility, increased capital investment, increased maintenance costs, greater difficulty in maintaining a balanced relationship in equipment, etc. Management is constantly faced with a decision

between the advantages of the general purpose machines and of the special machines. The volume of production and available funds bulks large in the final determination of the problem. Frequently a compromise between maximum specialization and general purpose equipment is reached.

Adapting general purpose equipment to special purpose requirements. In attempting to compromise between the expense with the attendant

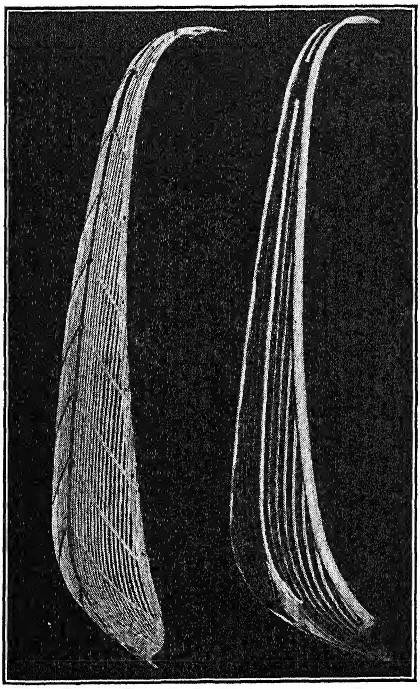


Courtesy "Automotive Industries."

Fig. 81. Welding Fender Halves in a Specialized Welding Machine Producing a 90-inch Flash-welded Joint in Seven Seconds. Pontiac Motor Co., Pontiac, Mich.

hazards of extreme specialization of equipment and the low production and high direct labor cost of general purpose machines, some managers have sought to adapt the standard machines to special purposes. Probably the best-known instance of this is the machine built by the A. O. Smith Corporation of Milwaukee to machine the fittings for the automobile frame. The various operating units of this machine which performed the different drilling, reaming, tapping, and milling opera-

base.[1] The various operating units of the machine could be assembled in whatever order or sequence the individual parts required. This was necessary because all the parts did not have the same operations. When the adjustments had been made the machine was an automatic machine. The respective operating units were largely general purpose machines; special bases, however, had to be made for these machines, since their manufacturers do not have standard interchangeable bases.



Courtesy Precision Casting Co. and "Automotive Industries."

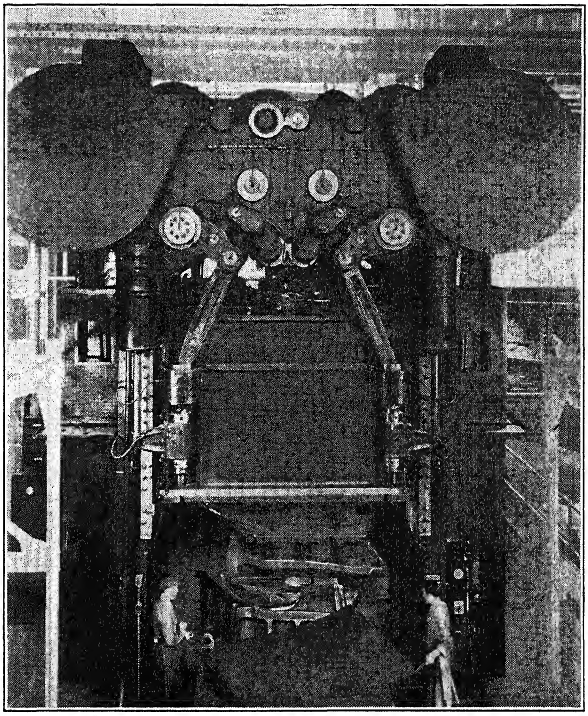
FIG. 82. Die-cast Automobile Radiator Grilles.

Another method of approaching the economies of special purpose machines while using general purpose equipment is to connect the general purpose machines by automatic feeds and conveyors and synchronize their operations by some timing device, either mechanical or electrical. The machines retain their flexibility in part at least and the timing devices and fixtures are essentially the only special features, since the conveyor equipment is frequently adaptable to various machines.

Changes that have influenced machine tool design and use. Machine tools and production tools have undergone tremendous improvement during the past decade. A part of this advance has been the direct result of research on the initiative of the machine builders and a part of it has arisen as a result of changes which they have had to meet but for which they were not responsible. The carbide tools would stand up under higher speeds and the machine builders had to design their machines to stand up under the new speeds. The use of higher alloy steels of greater strength and the accuracy of gear forms have permitted the use of smaller mechanical units of higher speed to fulfill the same functions that previously required mechanisms of larger size. Many

[1] See Franklin E. Folts, *Introduction to Industrial Management*, McGraw-Hill Book Co., Inc., New York, 1938, pp. 54-56; also Bulletin No. 210, A. O. Smith Corporation, April, 1929, p. 13.

manufacturing functions previously requiring machining operations are now being performed by other methods, or at least are reducing the demands on the machine tools. Foundry castings are being produced closer to size, thus reducing the amount of metal that has to be removed. The same result has been achieved by the improvements in forgings. Finishing flat surfaces by coin pressing and producing forms by press work or by flat broaching have changed the machining requirements considerably. Grinding, particularly in the case of rough castings, has greatly reduced the amount of metal that was formerly removed by boring, turning, and facing. With the shorter productive cycle greater emphasis has been placed on the non-productive functions that are necessary in machine operations. These in some instances have become automatic, semi-automatic, or appreciably reduced by mechanical helps. Die castings of parts not requiring great strength have also greatly reduced machining requirements. (See Fig 82.) This process of evolutionary technical development has not ceased but is continuing unabated.

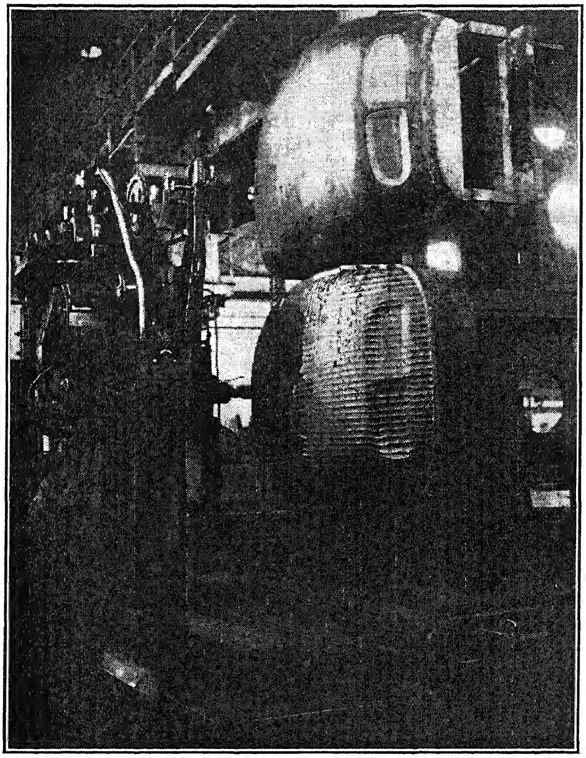


Courtesy "Steel."

FIG. 83. 800-ton Press Used in Shaping Rear Panels for Sedan Bodies at Ford Motor Company Rouge Plant, Dearborn, Mich.

Amortizing equipment costs. New expenditures will frequently be incurred in order to improve quality, with the hope of placing the product in a better competitive position, even though the equipment may not show any direct manufacturing economies in the immediate present. The same situation holds with respect to improving working conditions involving either safety or health. However, most expenditures are carefully checked against the anticipated savings in manu-

facturing costs. In the case of special purpose machines to be used in the manufacture of a product having a high style factor, it is customary to require that the machine pay for itself in a relatively short time, especially during the expected life of the particular style for which it was designed. In the automobile industry the special tools, dies, and fixtures are expected to pay for themselves during the life of the current model, which is usually one year. On the other hand, the more general purpose equipment is expected to pay for itself during its effective life. General purpose equipment in this sense does not have to be universally used but in general use in the particular industry. For instance, the gigantic press shown in Fig. 83 is in reality used in relatively few industries, yet its reasonable life expectancy in the automobile industry is not less than ten years. Likewise the large Keller die-cutting machine shown in Fig. 84 will have a relatively long life.

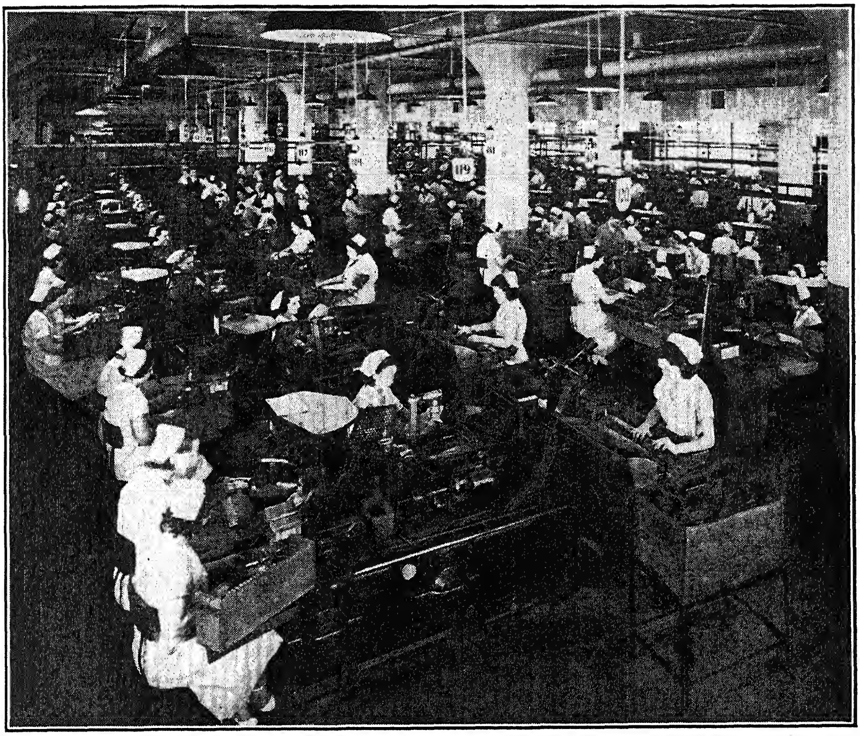


Courtesy "Automotive Industries."

Fig. 84. Die-making on a Large Scale with the Keller Die-cutting Machine. This huge die for one-piece body top is made of nickel-chromium iron with alloy steel inserts at wearing parts. The cutting tool of the Keller Machine is guided by the finger which passes over the mahogany master model, above the die. Koestlin Tool and Die Corporation, Detroit.

Workplace standardization. Workplaces may or may not include machinery, since the operation is a hand or machine one. In machine operations, the workplace is of a character determined as far as possible by the nature of the machine. In tending spinning frames or looms, the workplace does not usually include a chair as a portion of the

standard equipment, because the nature of the operation does not give the worker much opportunity for sitting down. In many cases, six to eight or more looms are attended by a single operator, and the job consists largely of walking from one to another and seeing that everything is running smoothly. On the other hand, standard machines working on products which allow the worker to remain seated permit the seating arrangements to become a portion of the standard workplace.



Courtesy Bayuk Cigars, Inc.

FIG. 85. Standard Machines Make Standard Workplaces. Cigar-making Department, Bayuk Cigars, Inc., Philadelphia, Pa.

(See Fig. 85.) Attention to the layout of production centers, such as that which has been given in this illustration, affords a high percentage of use of the floor space. It will be seen that the workplace afforded the several workers on a cigar-making machine includes a bed for working up tobacco for the worker who is preparing the filler (e.g., worker under section 119 marker); and standard containers for the workers who are inspecting the finished cigar as it comes from the machine (e.g., worker in lower left-hand corner).

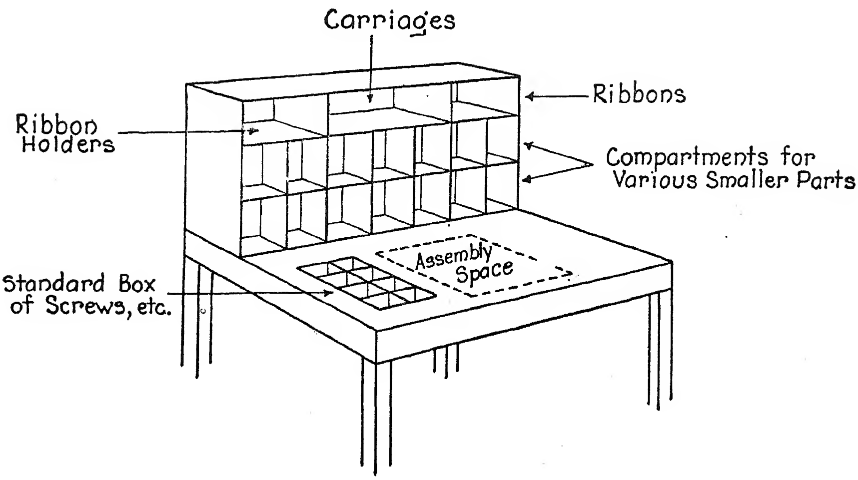


FIG. 86. Standardized Assembly Bench, L. C. Smith & Corona Typewriters, Inc., Groton, N. Y.

Standardized workplaces come to be of particular value in hand work such as the assembly of small products. Figure 86 illustrates a standard workbench for the assembly of typewriters. Each of the small parts that goes into the final assembly has its particular compartment, built to fit. These compartments are so arranged that the article may be removed by the left or right hand, depending upon the sequence of operations while it is being assembled, or which should carry it to the assembly. Small screws and nuts are conveniently held by standard parts-carrying boxes that fit into the top of the assembly bench. Motion economy sometimes requires that the same small part be in two positions on the bench if this part is used in more than one place and is picked up and handled by both hands simultaneously, or in some cases, possibly in a different sequence.

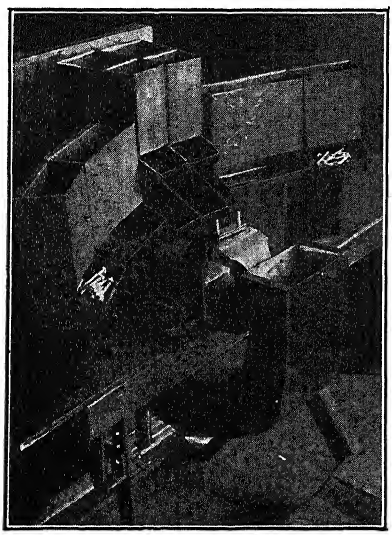


FIG. 87. Standard bins are used in the layout of the workplace for the assembly of clamps. *From Barnes "Motion and Time Study."*

Figure 87 shows a slightly different type of standardized arrangement for small parts. In this layout, special emphasis has been laid

upon having the respective parts as near as possible to the hand that will be used to pick up the part for assembly. This is a typical result of motion economy studies. The same principle illustrated here for the

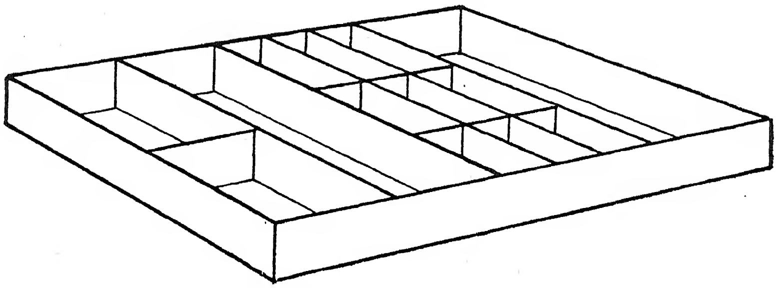
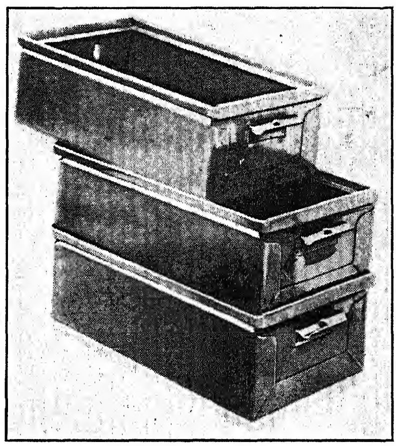


Fig. 88. Standardized Box for Small Parts.

factory may be applied to standard arrangement for office workers, especially the typist.

Standard equipment, other than machines. Equipment to hold parts for assembly has been developed by many companies to fit their particular needs. Figure 88 illustrates such a box, utilized at the Philadelphia plant of the General Electric Company in the assembly of small switches. A sufficient number of each part are provided, usually 25, for each lot being manufactured. If one part is used twice in the assembly, for instance, a screw of a particular size, twice the number of this part is provided. Much study may be given the arrangement of the divisions of the boxes, so as to entail the least labor in assembling. Another type of box is the standard metal tote-box which has been developed to transport material from one operation to another. (See Fig. 89.) If these are of proper size they may be utilized for a standard number of each part. They are very sightly and durable and will nest one into the other when not in use, thus economizing in both floor space and handling labor.

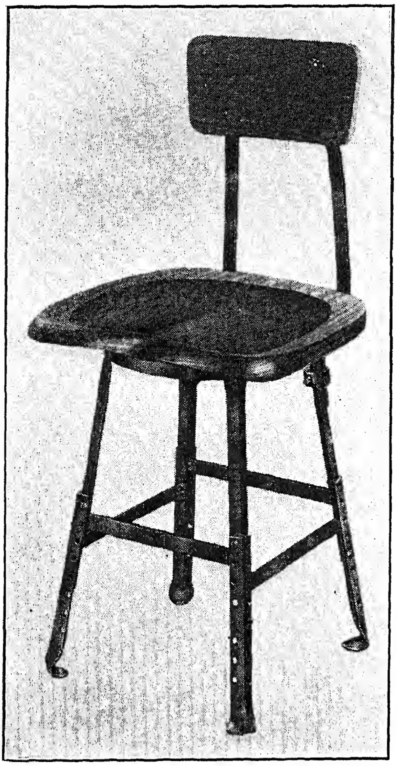


Courtesy Standard Pressed Steel Co.

Fig. 89. Standard Tote Boxes.

Standardization of the worker's chair, particularly of its height, has been given much study. In a factory where the work permits sitting, it will be found that if the management has not provided chairs, the

workmen have improvised seats out of old nail kegs and packing cases, or have made themselves rough benches or stools. If the chairs are really an aid to the work, they should be furnished by the management, and, as far as practicable, should be scientifically standardized and suited to the purpose for which they are to be used. It is in the telephone exchanges that the importance of a proper chair has been, perhaps, most conclusively shown. Endeavors to improve and speed up the service have resulted in close attention being given to the proper type of chair, and the adjustable-height, back-fitted chair that is used in all exchanges today was developed and has become an enormous aid in the handling of the great traffic passing over the large city switchboards.



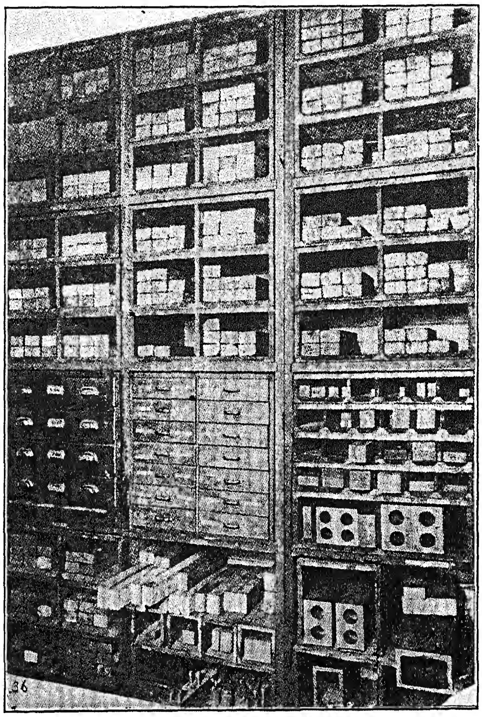
Courtesy Royal Metal Manufacturing Co.

FIG. 90. Standard Commercial Factory Chair.

The proper height of the workplace and the chair depends largely on the nature of the work.[2] Generally speaking, on heavy work, it is desirable to keep the lifting distance small. On the other hand, workers seated on ordinary chairs should not be required to bend too much; or when the material handled is quite light, it may be profitable to allow the height of workbenches to be determined by the machine-bed level of nearby machines. Transfer trucks or tables on wheels of the same height can then be employed and the bench hands provided with higher chairs. This arrangement has been found profitable in the finishing department of one large paper company and has expedited considerably certain operations that must be carried on both on machines and on benches.

[2] One large candy manufacturer employing many girls in a wrapping operation, selected a standard chair and in hiring employees specifies certain heights. This will work when the supply of labor is abundant but is not very scientific when the labor supply is scarce as there is no direct correlation between productive efficiency and a particular height of the employee. It would be better to have adjustable

One of the most satisfactory forms of commercial factory chairs is illustrated in Fig. 90. The broad saddle seat, the adjustable legs, and the close-fitting back make this exceptionally effective. Footrests may be needed, but these can be readily attached. The chairs in Fig. 85 are similar to that just described. Such equipment is of particular value when women are employed, as has been demonstrated through independent surveys made by the State Departments of Labor of New York and Pennsylvania, and by the General Electric Company.



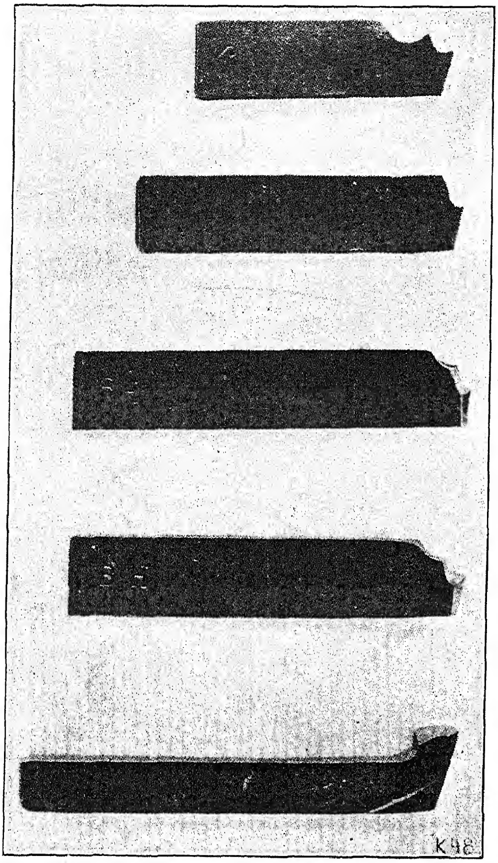
Courtesy H. K. Hathaway.

Fig. 91. Section of Tool-room, Showing Standard Woodblocks Stored in Standard Bins.

Standardization of tools. Standardization of tools began with the experiments of Frederick W. Taylor at the Bethlehem Steel Company on the use of that common tool, the shovel. He showed that workmen, to be most effective in their work, must have a type of shovel peculiarly suited to the material which they are handling. His experiments indicated that a shovel-load under ordinary conditions could best be handled if it consisted of about 21 pounds. It therefore followed that, if the 21-pound load is to be secured in all cases a shovel to be used in iron ore must be of a different size from one to be used for ordinary dirt, and a shovel to be used in moving coal must be smaller than one used for moving ashes. To many people in industry, despite these experiments, a shovel is still a shovel. Frequently no particular attempt is made to see that the laboring gang is provided with different types of shovels, based on the material being worked on, or on what is being done with it. Nevertheless, great strides have been made in numerous cases; particularly in the contracting business, there has been much attention paid to the proper type of shovel.[3]

[3] See D. J. Hauer, *Modern Management Applied to Construction,* McGraw-Hill Book Co.

In the usual types of factory work, it will be seen that there are two general kinds of tools used on most jobs, first, the auxiliary tools used in the preparation of the job and its removal from the machine and, second, the actual tools used as a part of the machine in the performance of the operation. To see a high-priced machinist, who operates a machine tool on which the overhead machine rate is also high, spend fifteen minutes trying to get a bolt ready to hold his work on a machine is the best possible argument for the standardization of auxiliary tools and for the practice of storing and issuing them to the workman along with the material to be worked on, as is done with the operating tools. Figure 91 illustrates proper storage of such tools.



Courtesy H. K. Hathaway.

FIG. 92. Lathe Tools (Side View). The bottom one is standard tool-machine ground; the others unstandardized-ground by hand of workmen.

Fastening-tools in machine-shop work may be given much attention, not only to insure their being available when wanted, but also to see that they are of the right type and are in good condition. Frequently the preparation time for operations is almost as long as the time taken for the operation itself. Therefore, proper auxiliary tools, which are usually inexpensive, will quickly become real money-savers. All industries employ auxiliary tools, such as wrenches and screwdrivers, which can be readily standardized.

The operating tools in a machine shop consist of cutting tools that go into the machine and are changed with each type of job that is put into the machine. The composition of these cutting tools varies greatly, and was completely revolutionized some years ago with the discovery of high-speed steel. New inventions are being perfected yearly, and

it is not at all uncommon to find a number of types of tool steel in stock in a shop. The presence of a large variety of types of tool steel in a shop is very desirable. However, some steps must be taken to insure the use of tool steel of the proper grade on each job. To leave this to the workman is to leave it to guesswork. Many shops can still be found in which tools made from a dozen different qualities of steel are used side by side, in many cases with little or no means of telling one from another. When one realizes that the cutting speed of the best air-hardened steel is, for a given depth of cut, feed, and quality of metal being cut, say, 60 feet per minute, while with the same shaped tool made from the best carbon tool steel and with the same conditions, the cutting speed will be only 12 feet per minute, it becomes apparent how necessary is careful attention to the utilization of the right tool on the right job. Carbon-steel tools are still used for many operations, as in accurate finish-cuts.

Tools are different, not only in composition, but in the method of grinding. The cutting edge was in past years largely put on the tool by the workman at the job, and he was accustomed to grind this edge entirely with respect to his own whims and prejudices. It can readily be seen that to use a tool ground the wrong way is quite as bad a practice as to use a tool of the wrong composition. There is a certain shape of tool best adapted to each individual kind of work, and the tool should be ground at certain definite angles which have been found to be the best by a long series of carefully controlled experiments. It is obvious that if all tools are to be ground to these correct angles, the responsibility for grinding them must be taken away from the men in the shop and placed in the hands of a man in the tool-room who has been provided with adequate tool-grinding equipment. Figure 92 shows the wide variations found in cutting tools used for the same job in one shop, compared with a tool for that job properly ground to conform to best practice.

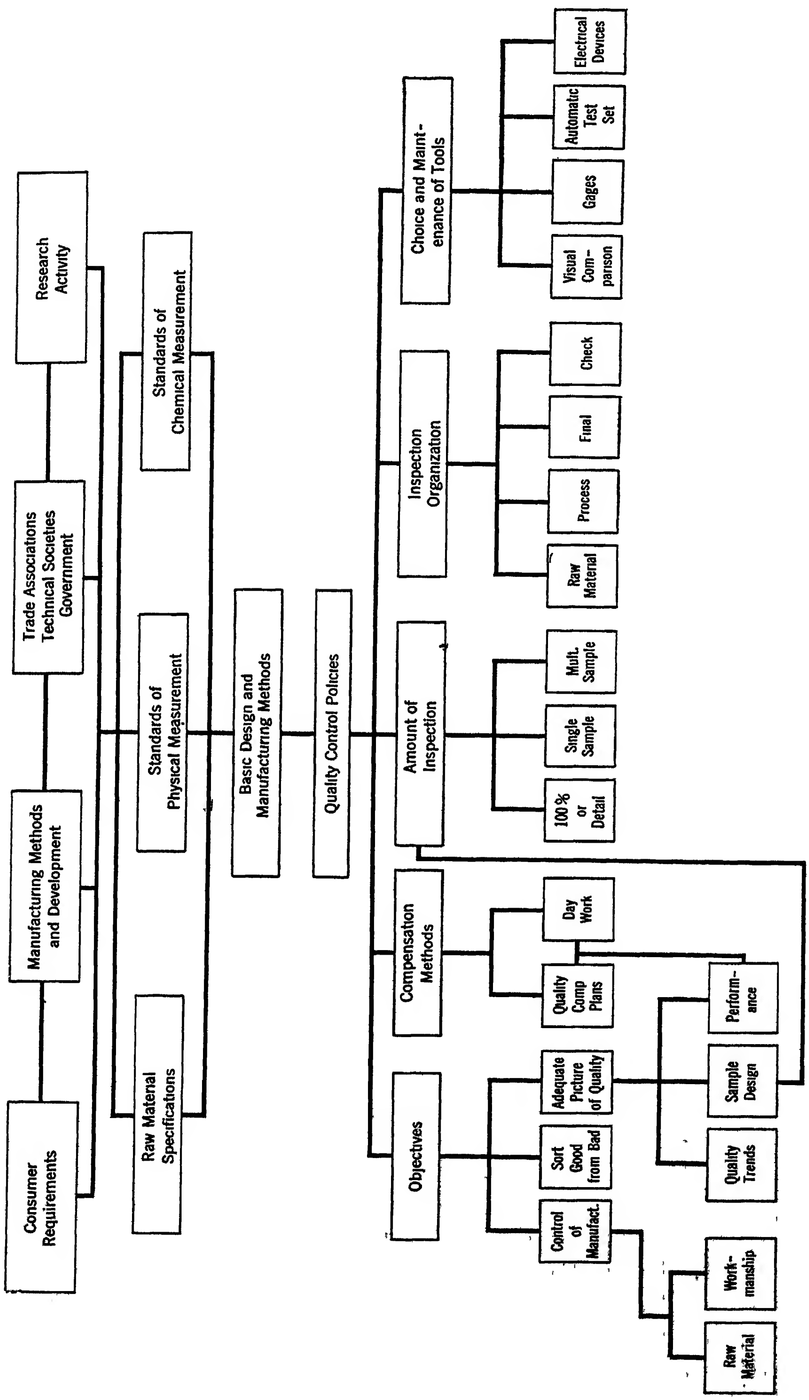
CHAPTER XIX

INSPECTION

Function of the inspection department. In general there are four major objectives behind the activities of the inspection department: (1) to control the quality standards of the manufacturing processes, operative inspection; (2) to aid in the location of the causes of defective work and cooperatively to assist in removing the causes, preventive inspection; (3) to sort acceptable from defective raw materials or work in process, remedial inspection; and (4) to provide management, through properly designed reports, with a picture of the quality of the product produced, a statement of the quality of the raw materials received, and a measure of the efficiency of plant operations, which is often used as a basis of payment to the worker. The control of quality standards in manufacture checks the workmanship of all operations in the plant. This is particularly effective when carried on with a view to preventing difficulties later. To cooperate with the manufacturing group in the location of the causes of defects and to aid in their removal is the highest type of preventive inspection, the one that pays the largest returns on effort expended, and the type that is becoming increasingly important in modern industry. The sorting of defective work in process or finished product protects the good name of the concern, prevents further expenditure on defective parts that must be rejected later, and protects the customer in his purchase. It is a necessity in plant operations, but the amount of this type of inspection decreases in proportion to the effectiveness of preventive inspection. To reject raw materials before they are started in production is in reality a form of preventive inspection. The providing of accurate records of the quality of raw materials, work-in-process, and the finished product gives management statistical data for guidance in operating control and policies.

Figure 93 graphically portrays the interrelationships of the various departments with the inspection department.

Quality characteristics. Inspection consists of the measuring of the qualities of a product or service in terms of established standards. These standards fix in measurable terms the qualities pertinent to a given serviceability of the product. The quality of a product may be defined as the sum of a number of desired related characteristics, such as shape, dimensions, composition, strength, workmanship, adjustment,



Courtesy John D Golder.

FIG. 93. Chart showing the Origin of Quality Control and Factors Considered in the Effective Use of Quality Control.

finish, color, etc. It is obvious that standards of quality should be a matter of record where possible. Wherever quality characteristics are not capable of adequate expression, they should be illustrated by a sample of the product showing the desired qualities. In such cases the product being inspected may be compared with the sample. It is not always an easy matter to describe certain desired qualities, such as abrasive resistance ability of a given tire tread design. It may require description in terms of a given standardized test such as wearing a given amount when run at a determined speed for a certain length of time under a specified load on a particular describable abrasive track wheel.

Types of inspection. Inspection may be classified under at least four different headings, depending largely upon the point of view or emphasis at the time of classifying, namely:

1. Remedial and preventive inspection.
2. Centralized, floor, or a combination of centralized and floor inspection.
3. Materials, work-in-process, finished product or final inspection, and functional inspection.
4. Visual, and non-visual inspection, such as chemical composition, tensile strength, ductility, etc.

1. Remedial inspection, as previously described, lays its major emphasis upon catching defects that have already occurred, thus protecting the good name of the manufacturer as well as the consumer and eliminating further waste by adding further work to a defective part or product. Remedial inspection or corrective inspection strives to filter the good from the bad. Preventive inspection gives special attention to the accuracy of manufacturing processes in order to avoid defects and waste. Preventive or constructive inspection emphasizes the positive attitude rather than the negative. Corrective inspection catches parts that are defective, and the worker is usually required to repair them on his own time or he is not paid for them if they must be scrapped, while preventive inspection often is used in connection with a special incentive for quality achievement. Preventive inspection does not necessarily have to be tied into any special wage scheme; neither does remedial inspection. The major difference between the two types of inspection is the emphasis of the one upon catching defects that have been produced and the other upon preventing their occurrence.

2. Centralized inspection refers to that method of inspection in which the product inspected is brought to a central location for inspection. It does not necessarily follow that there will be only one place in a plant where inspection of this type is carried on. As a matter of

fact, there might even be two or more places in one large department where parts are taken for inspection. The major distinction is that the product is not inspected on the floor at or adjacent to the place of production. Centralized inspection usually is performed in a place especially set aside for the purpose, often within an enclosure, and specially adapted or equipped for the purpose. Centralized inspection carries the *principle of specialization* somewhat further than floor inspection. Under certain operating conditions and in the case of certain products centralized inspection has some outstanding advantages as follows:

1. It is easier to supervise the inspectors; their tasks may be subdivided, and a less skilled type of worker may be used.
2. The inspector's output should be greater because of better working surroundings, less interference, and increased speed arising from specialization.
3. There should be less interference with the workers in production and better shop housekeeping when the products are not held at the workplace for inspection.
4. Centralized inspection produces more impartial inspection; at least the inspector is not under the direct strain of rejecting the work of a man with whom he is in personal contact.
5. Centralized inspection facilitates the use of specialized equipment such as the X-ray, radio amplification, special lights, and other delicate mechanisms.
6. Records of approved and rejected parts together with the source of each are more readily kept under centralized inspection.
7. Production control is facilitated when parts pass through a central location where a total count of approvals and rejections is made.

Although centralized inspection has its advantages for certain situations, there are also some inherent disadvantages and in some situations such as the manufacture of heavy parts or products it may be highly impractical. Centralized inspection tends to increase the amount of transporting material save where the inspection is performed in the stores department or the finished stockroom when these are used. There also tends to be an increased inventory of work in process in the case of centralized inspection unless the inspection is performed in the stores department or stockroom. It is also apparent that centralized inspection is not feasible in progressive manufacturing at least for the parts, although the final product may be centrally inspected.

Floor inspection consists of inspecting the part or product at or adjacent to its place of production. If the volume of production justifies an inspector's remaining in one place as on an assembly line or in a

given work center, the inspection is relatively stationary as far as location is concerned. Not infrequently, however, an inspector may be what is known as a "roaming inspector" and covers a large area. The nature of the product, the type of processing, and the inspection itself control the movements of the inspector when inspection is performed on the production floor.

3. Materials, work-in-process, finished product, and functional inspection form a classification of inspection when viewed from the point of view of the items inspected. This group is often subdivided into inspection of purchased or raw materials and manufacturing inspection. The essential characteristics of inspecting work in process have been covered above under the discussion of centralized and floor inspection. There are a few other observations, however, in connection with *manufacturing inspection* that may be in order.

Inspection problems in assembly industries are somewhat different in character from inspection problems in continuous industries. In the latter, the general problem of manufacturing inspection is to develop good quality in the final product. Frequently the purpose of the inspection work is to rate the product as to quality after it is produced. In continuous industries, such as the manufacture of paper, textiles, or chemicals, a defect in manufacture is likely to make the material a "second," and there is frequently no possibility of correcting the defect. Thus the operation of an inspection department in such industries includes prevention of defects wherever possible, noting of defects after they have occurred, and decision as to whether such defects may be remedied or whether the goods must be placed in the lower classification of product or scrapped.

In assembly industries inspection includes attention to accuracy of manufacture and to interchangeability. The American system of manufacture has been erected on the basis of interchangeable parts. Although the consumer is likely to look upon interchangeable parts from the standpoint of possible availability for repair purposes, this is a very minor consideration. From a production control standpoint, as well as from the standpoint of the assembly operations, this interchangeability of parts in assembled products is essential in order that specific parts, when started in manufacture, need not be designated as being for specific pieces of final product. Inspection of components during process affords the inspection department an especially good opportunity to practice preventive medicine in assembly industries.

There is one phase of inspection of the finished product that remains to be examined, namely the *engineering inspection.* Certain types of products, such as large machinery units, are completely fabricated on the assembly or erection floor and accurately tested by technical experts

to determine their operating characteristics. Large motors, turbines, generators, etc., are thus tested by the Allis-Chalmers Corporation. In some instances representatives of the purchaser, particularly in the case of governmental purchases, are present at these inspections. Airplanes and steamships are usually either flight tested or given trial runs.

Functional inspection in the case of parts usually consists of placing the part in a skeletonized assembly and operating it to see if it performs the desired function.

The fourth type of inspection, *visual,* merely refers to the method of inspecting. The title is self-explanatory. This type of inspection has been sufficiently covered in discussing the other three classifications.

Location of the inspection department in the organization. As has been pointed out in Chapter VII, an inspection department must never be made directly subservient to the will of those who are engaged in increasing the quantity of production. Unless quality of work is but a very small factor in the successful operation of a plant, the following scheme for the location of inspection work should be avoided.

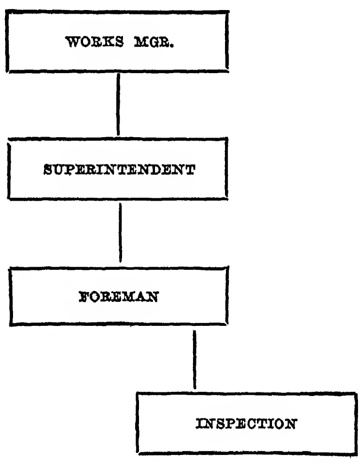


FIG. 94. Poor Location of Inspection Department in Organization.

If the foreman has charge of inspection work, manifestly he cannot be expected to be rigorous in his application of manufacturing standards and, at the same time, be forcing quantity production through his department. This does not imply that the foreman should not be interested in quality; quite the contrary, the foreman has as one of his major responsibilities the creation of a quality product.

Means should be provided to see that quantity production should not be credited to a foreman unless quality is good. On the other hand, decision as to quality must be taken out of his hands.

If quality is not of excessive importance in an industry, inspection forces may be maintained as a staff department under the superintendent, as illustrated in Fig. 95. This places the foreman in a position of receiving instructions, regarding amount of product to be produced and the quality of that product, from two sources. He must endeavor to correlate his instructions and, in case of conflict in instructions, the matter will naturally be referred to the superintendent for a decision.

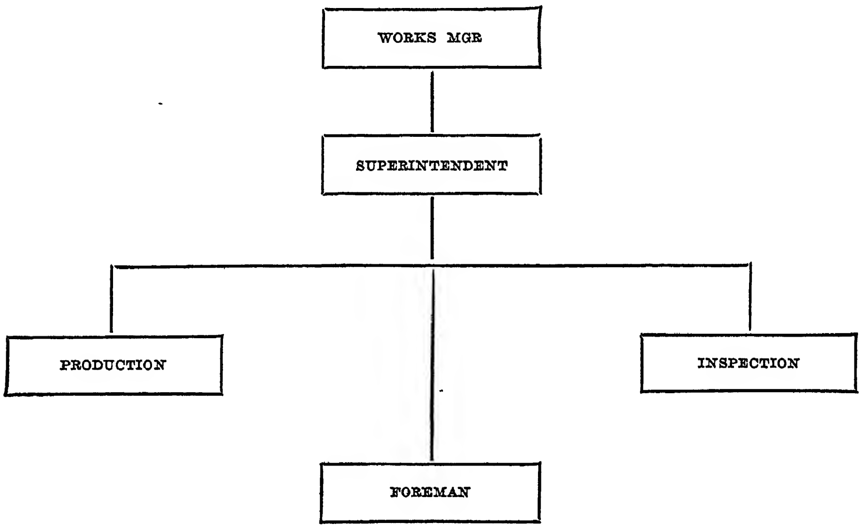


FIG. 95. Location of Inspection Department. If Quality Is Not of Excessive Importance.

If quality is of maximum importance, as in the case of the production of scientific instruments, or in goods which are sold mainly on the basis of quality rather than on the basis of price, the inspection department should probably become a major manufacturing function directly under the control of the works manager (Fig. 96). The inspection function would thus hold a position analogous to that of the purchasing department or the engineering department on the typical organization chart (Fig. 9).

The inspection department can be most helpful when it endeavors to prevent errors in manufacture, rather than criticize results and turn back defective material for reworking or scrap. Though all errors cannot be corrected prior to their occurrence, if the inspection department will practice preventive medicine on the product, not only will it become a dividend-paying portion of the organization, but it can more readily cooperate with the subexecutives responsible for quantity. The inspection department is an effective aid to the foreman, the planning depart-

ment, the training department, or the methods department, whichever of these may direct the methods of operation and instruction of the worker. If instruction as to causes of defects be made a major function of the inspection department, the idea of carrying on the preventive medicine campaign will have been greatly furthered.

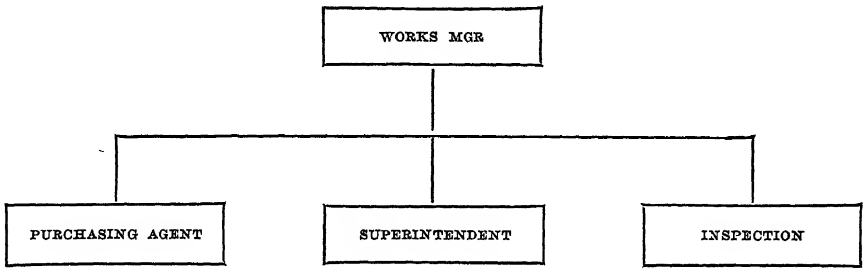


FIG. 96. Location of Inspection Department. If Quality Is of Maximum Importance.

The inspection department should have full control, both over inspection of purchased materials and parts, and over inspection incident to production. The first enables it to maintain the material standards which have been set, and the second makes possible the maintenance of product standards. Frequently the work of inspection incident to production will closely approximate the type of inspection on purchased materials. An instance of this is found in the case of a part to be made from soft steel for economical working, and then to be hardened and tempered to fit it for the service requirements of the finished product. This illustration should indicate the necessity of an inspection department's having full control of all inspection operations.

Figure 97 portrays the quality control system of a large electrical manufacturing enterprise. It illustrates how intimately the consumer's complaints are tied into design and inspection engineering, the sources of most of the technical standards. This chart also shows the progressive inspection from the raw materials to the finished product. Figure 98 shows the quality control system of a large steel mill. This system also exemplifies the closed inspection cycle with the consumer as the end man, both sending and receiving.

The four major problems facing those who are developing the operating methods of an inspection department are when, where, how much, and how to inspect.

When to inspect. Decision of when to inspect cannot be made without considering the importance of quality in the product, and the possibilities of reworking the product after the various operations. It is easy to set up so many quality checks that the responsibility for

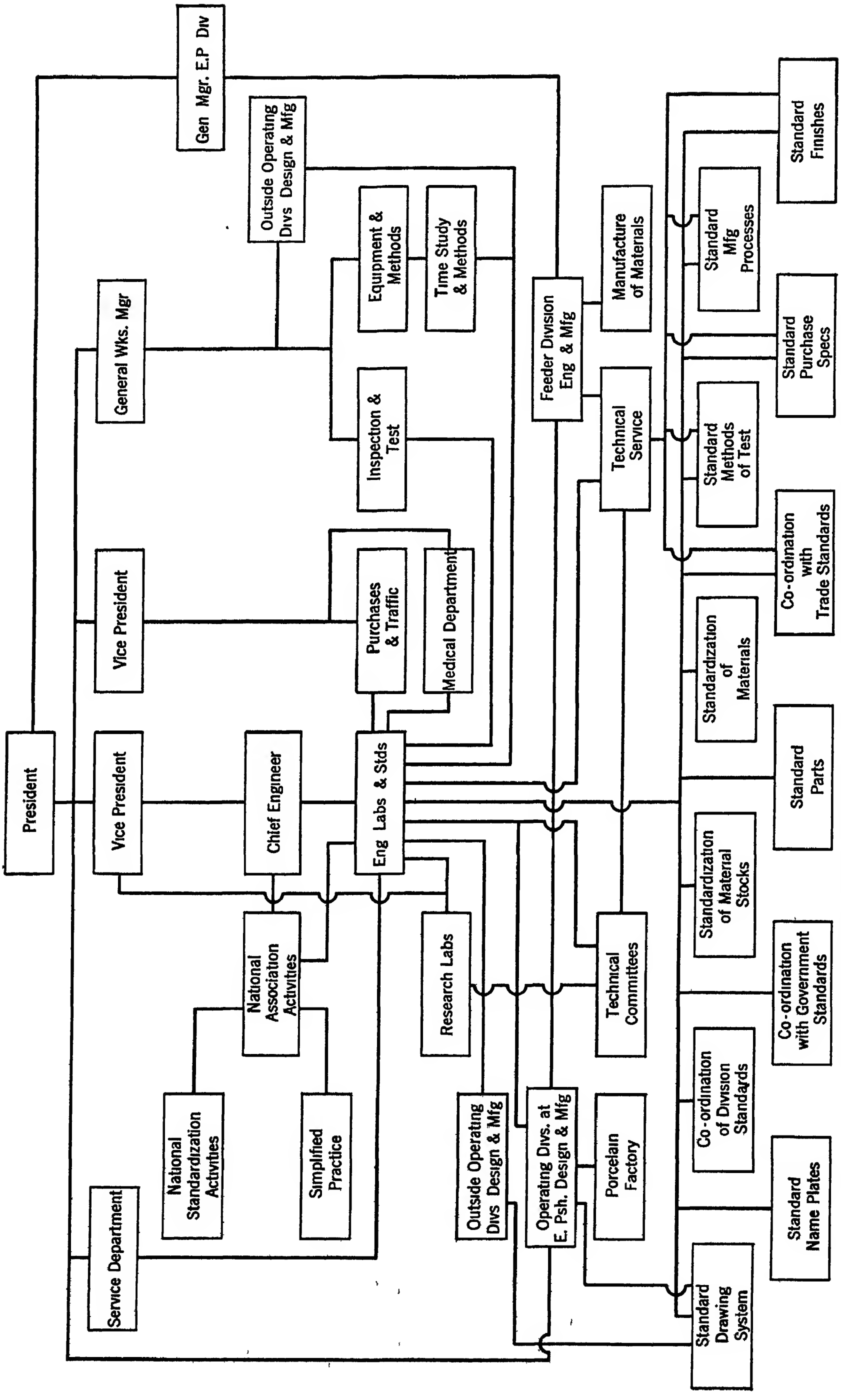


FIG. 97. Standardization System, Westinghouse Electric & Manufacturing Co.

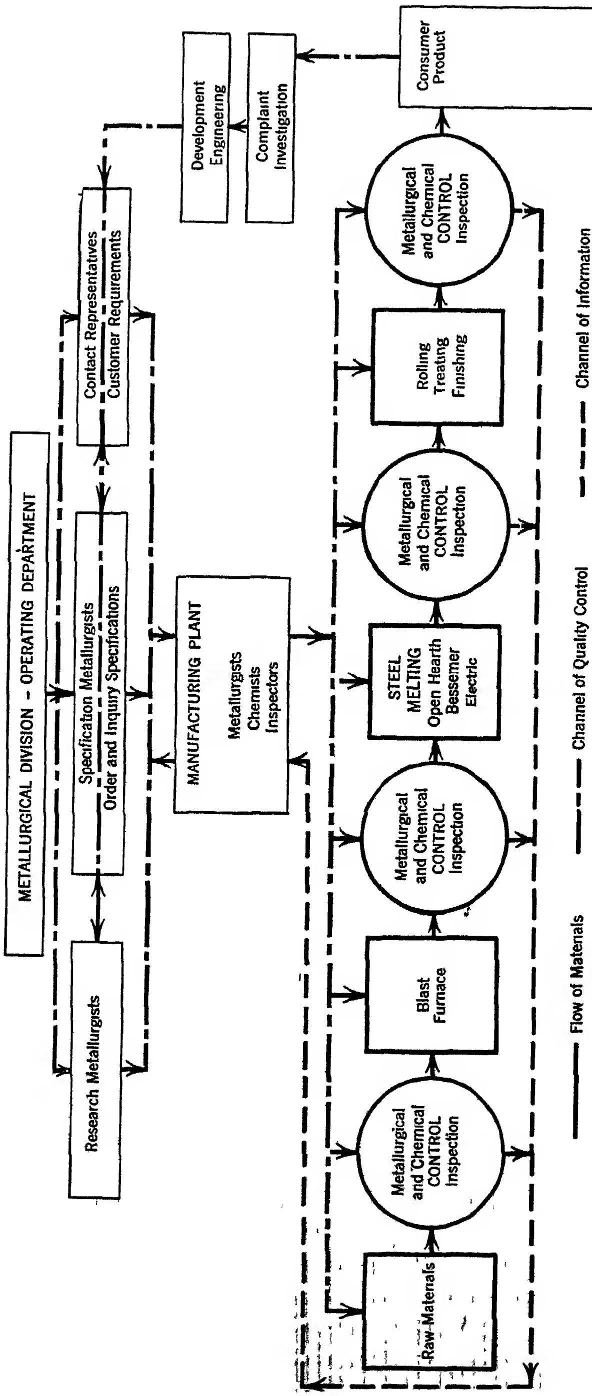


FIG. 98. Chart of the Quality Control in the Carnegie-Illinois Steel Corporation, Compiled from Data Presented in an Address by Mr. Richard W. Simon before the American Management Association. (See *A.M.A. Production Series*, No. 114.)

quality is shifted in reality from the shoulders of the workers and foremen to those of the inspection department. This is fundamentally wrong, as, even in those industries which have the fewest quality demands, the workers should be held responsible for quality within the set limits.

As a minimum, inspection should be made of the final product before it is shipped to the consumer or sent to stock. In certain cases inspection should be made after each operation. Between these two extremes lies the usual situation. In some industries inspection is so important for the following operations, and for the maintenance of product standards, that it must be regarded as a process in the manufacturing cycle just before assembly operations. Usually a series of operations can be grouped, and the product inspected after the last of this group of operations. However, after any operation in which the worker is not able to measure quality exactly, inspection must be made.

In machining operations of an automatic or semi-automatic nature, parts should be carefully inspected after each new set-up until they meet specifications, after which they may be inspected at infrequent intervals just to make certain that there has been no change in the set-up or that there is no serious variation arising from wear of the cutting tools.

How much to inspect. The more automatic the machine, the less attention need be given to inspecting the product after the initial set-up inspection. In high quality products, or products which are manufactured largely through skill of the worker rather than skill of the machine, much more of the product must be inspected than in the case where the machine, once set up, is likely to turn out standard-quality products for a considerable time without adjustment. In the latter case, inspection must be made frequently enough to ascertain that the equipment is operating satisfactorily and does not need adjustment other than the usual adjustment made by the worker on the job. In the former case, frequently 100 per cent inspection will be necessary, that is, every unit of product must be inspected after every operation.

Sampling is a means of greatly reducing inspection costs, provided proper checks are instituted. The product, under sampling, may be inspected while in production, by checking some of the pieces that the worker has just finished, or the product may be inspected in an inspection department after the operation has been completed on a given lot. On continuous processes, such as those which use process conveyors, check inspection is made by a walking inspector who may come to any point of the line at any time and check a unit of product at any point of completion. One method of checking sample inspection is to over-inspect lots which have already been inspected, another is to have an inspector check

through a lot which he has already handled, after the lot number has been changed so that it will not be recognizable.

Some special considerations in inspection by sampling. Theoretically, sampling as a method of inspection should not be used until the production processes have been standardized and brought under control through the elimination of assignable causes of quality variation. Investigations have shown that statistical methods provide the best means of detecting the assignable causes of variations and make it possible to establish limits within which variations in any quality of interest to management should be left to chance.[1] After the elimination of the assignable causes of quality defects, quality tends to settle down to limits of variation attributed to chance. Further studies have led to the conclusion that once this point of control has been reached there usually is no practical advantage in further inspection to eliminate chance variations.[2] Under these conditions detailed inspection may logically be replaced by sampling inspection with considerable savings in inspection costs.[3]

The adoption of an inspection plan by sampling is based on the premise that a certain per cent of the output will not conform to the standard specifications. This may be specified as an allowable percentage defective in any lot inspected in determining between a satisfactory lot and a rejected lot. According to the laws of chance, a sample will occasionally give a favorable indication for a bad lot, resulting in the passing of this lot for use in further production or for delivery to the consumer.[4] This is often called the "Consumer's Risk." In addition to the consumer's risk there is another variable, namely, a value for the average per cent of defective product that will generally exist in any accepted lot over a long period of time. This variable is known as the "average outgoing quality limit" and is defined numerically as the probability of passing any lot submitted for inspection which contains the previously determined tolerance number of allowable defects.

A third factor essential to the design of a workable sampling scheme for inspection is a knowledge of the average per cent of defective parts existing in the product submitted for inspection. This factor known as the "incoming process average" is obtained from inspection records of previously inspected lots and is an estimate of the expected quality

[1] See *Mechanical Engineering*, November, 1932, p. 778, "Applications of Statistical Method in Engineering and Manufacturing."

[2] W. A. Shewhart, *Bell Telephone System Monograph, B496,* "Economic Quality Control of Manufactured Products."

[3] Frank J. Feely, *Mechanical Engineering*, October, 1935, p. 641, "Quality Control in Manufacturing."

[4] H. F. Dodge, and H. G. Romig, *The Bell System Technical Journal*, October, 1929, p. 628, "A Method of Sampling Inspection."

under normal conditions. See Fig. 99 for inspection form from which this information is collected. The extent of the fluctuation from the "incoming process average" indicates the control or lack of control

INSPECTOR'S DAILY REPORT

Job No	Shop Order Number	Piece Part Number	Total Lot Amount	Time Started	Time Worked	Sample Inspection				Detail Inspection		Rate per Hr	
						First Sample		Total Sample					
						Total	Def	Total	Def	Total	Def		
1													
2													
3													
4													
5													
6													
7													
23													
24													
25													
Clock No.		Name			Dep't				Date				

(Front)

DEFECT SUMMARY

Job No	Type of Defect / Piece Part Number																		
1																			
2																			
3																			
4																			
5																			
6																			
25																			
	Totals																		

(Reverse)

Fig. 99. Inspector's Daily Report.

during processing and is of vital importance in considering the size of the sample required.[5]

It should be acknowledged here that in actual practice much of the

[5] See John D. Golder, *Quality Control in Selected Industries*, p. 70, a master's thesis, Northwestern University, 1939 (unpublished).

inspection by sampling is not based upon scientific use of statistical processes but rather upon empirical judgment. This accounts in part for some of the turmoil in which inspection departments and producing units frequently find themselves.

The number of inspectors required. The ratio of inspectors to production workers depends upon several factors; namely, the nature of the production process, the relative quality group of the product, the type of equipment used, the organizational set-up, etc. It is obvious that a continuous process industry producing a single product would require less inspection than a jobbing type of industry producing many types of quality products. Institutions producing a high quality precision type of product also require more inspectors than the same general type of industry producing a lower quality product. Again the special purpose machine used where volume justifies it requires less inspection of its product than where the same item is manufactured by general purpose machines. It is true that the special purpose machine, itself, may require more checking and maintenance than the general purpose machine but the maintenance group is not usually classified with the inspectors. The organizational set-up may also influence the number of inspectors required. Where the direct supervisory force is adequate to keep a close check on the quality of production the amount of inspection necessary to measure quality is reduced. Modern precision equipment and techniques have greatly reduced the number of inspectors required to maintain the same high quality.

Inspection of parts produced on assembly lines. An inspector may be stationed at the end of the assembly line, who not only inspects, but counts the number of good pieces for which credit will be given. In case any parts are thrown out for defects, it is the practice to require the line to make the repairs without extra compensation. This makes for worker inspection as the processes are being carried on. However, on intricate assembly lines, such as a motor assembly, there must be floating inspectors who inspect periodically at the end of one or more of the group of operations.

How to inspect. Inspection department operation is facilitated through the development of an inspection code which is known to all concerned. This inspection code, which should be developed in writing if possible, should indicate the standards which are set up and should also indicate to the inspector the most frequent causes of defects in manufacture. A code should be rigid as to requirements, but the requirements should be reasonable in order to secure the cooperation of others in the production end of the organization. The inspection code, of course, becomes in a sense the code of the organization with respect to standards of material and of product.

Manufacturing tolerances should be set up with great care in order that unnecessarily high precision, and attendant high manufacturing costs shall not be required. Carefully studied tolerances will prevent these wastes of unnecessarily high precision. But the limit, as set up by the tolerance, should not be looked upon as the dimension or quality to aim at. Many manufacturers have frequently made the mistake of working to outside limits, with large rejections as the result; in other words, they have aimed at the outer circle of the target, rather than at the bull's-eye. Although the shot will count if it hits the outer circle, nevertheless it will hit the target more frequently if the bull's-eye be aimed at.

Quality is a variable, and exactness of measurement is oftentimes questionable. Although tolerances are adopted as a means of quality control, still there may be means of saving units which do not come within the allowable limits. Therefore, rejects of valuable parts should be overinspected, perhaps by line production men, to determine if it is worth while to try to save the unit by a special manufacturing process.

On machined parts, "Go and no-go" gauges that are set at the proper limits provide a quick way of checking the parts without gauge adjustment. Many devices can be set up in the inspection cage or on the inspection bench which will determine positively whether a part is good or bad, without elaborate adjustments.

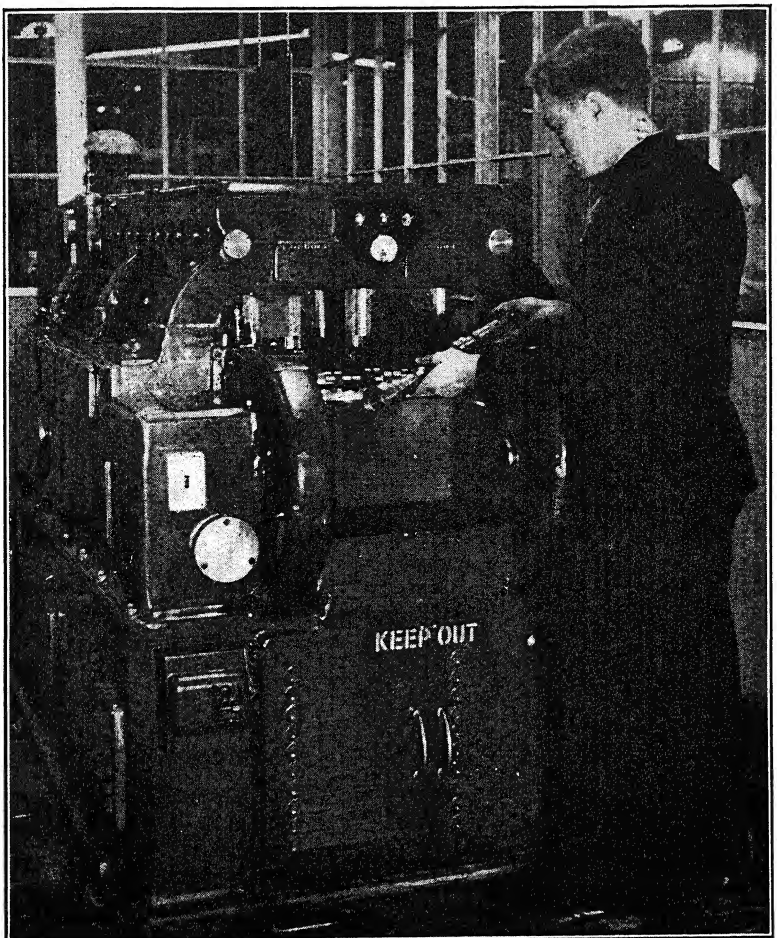
An inspection department may be organized by having inspectors in charge of each operation, department, or unit of product responsible for that type of product, and reporting to a chief inspector only on matters of broad inspection policy. Or the department may be organized by having a large number of inspectors of meager authority do the physical work of inspection, calling the attention of over-inspectors to defects, or having their work checked by over-inspectors. This is particularly applicable in large companies which must have inspection departments with a rather large personnel.

Any inspection system should certainly provide for tracing defects to the individual worker who caused them, and should provide some means of insurance against their recurrence. Such methods tend to make workers their own inspectors, make possible the reduction of the inspection force, and provide for the smoother flow of materials through the manufacturing processes. Such a system should be tied up with some scheme of reward for quality or penalty for failure to reach standard quality.

Tools and equipment used in inspecting. Many phases of inspection may be performed by touch or with the unaided eye; however, even visual inspection of colors and surface defects and finish inspection by touch often are facilitated by special lighting arrangements or such a

simple thing as a canvas mit over the tips of the fingers. Inspection aids vary in complexity from the simple plug gauge all the way up to the complicated machine for inspecting camshafts, Fig. 100, and the X-ray machine.

The different types of inspection equipment may for convenience be



Courtesy "Steel."

FIG. 100. Electrically Operated Automobile Camshaft Tester at Ford Motor Company Rouge Plant, Dearborn, Mich.

divided into five groups, namely, production gauges, automatic testing equipment, the X-ray, electrical devices, and laboratory equipment.

1. *Gauges.* The manufacture of interchangeable parts requires precise duplication of these parts within established tolerances. By far

the most common form of measuring device used in measuring conformity to standards is the gauge. In the metal trades in addition to the micrometer, familiar to students of high school physics, gauges may be classified according to their purpose: working gauges, inspection gauges, and master gauges. Working gauges used by the workmen in performing the operations are limit gauges for checking each step as it is performed. Inspection gauges are used by process inspectors to check the product before its final assembly with other parts or before sending it to stock. Master gauges are used to check the working and inspection gauges to insure a suitable degree of precision in the gauges used to check actual production.

Plug gauges are among the oldest and simplest tools used in inspection. They consist of pieces of metal turned to the maximum and mini-

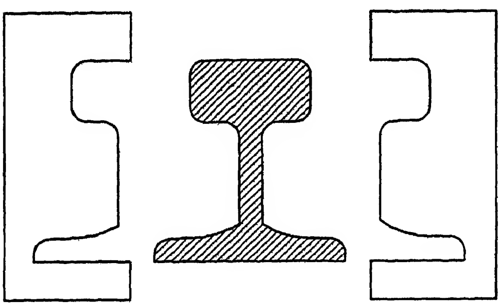


Fig. 101. A Simple Contour or Profile Gauge.

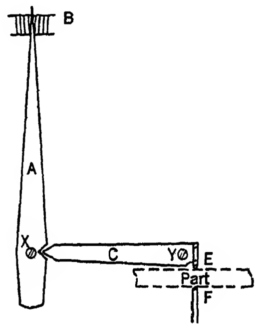
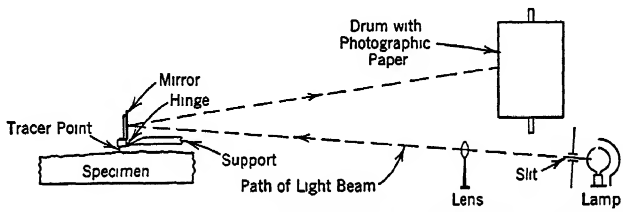


Fig. 102. Multiplying-lever-indicating Gauge.

mum dimensions. It is customary to incorporate these two dimensions into one gauge to facilitate rapid inspection, thus producing a two-step plug gauge. Inspection consists of inserting the gauge in the hole and observing the fit. Profile or contour gauges perform a function similar to that of the plug gauge but measure contours. Figure 101 illustrates a contour gauge for checking the cross-sectional area and contour of a railroad rail. Figure 102 illustrates the multiplying lever indicating gauge, the principle of which has been adapted for many types of operations and processes, from checking the thickness of a given part already processed to checking the product during continuous operations such as gauging the thickness of fabric as it is being rubberized while going through a calendar. Master gauges are the gauges which are used for checking working and inspection gauges. These gauges are accurate to a very high degree and usually consist of discs or blocks ground to exact dimensions. They are used to check the operating gauges by having the production gauge check the dimensions of the known master.

2. *Automatic testing equipment.* Automatic testing equipment has made remarkable progress since the introduction of the photo-electric cell. Some applications of its use to industrial inspection are as follows: detecting fine cracks in polished surfaces, inspection of storage battery caps for vent holes, the control of enamel thicknesses on wire; the rejection of non-sharp razor blades, color measurements, and the calipering of steel balls. Other uses of this mechanism include the grading of cigars, tile, missing labels on canned goods, the inspection of tin plate and the matching of false teeth.

The electrically operated camshaft-tester, Fig. 100, used by the Ford Motor Co. at its Rouge Plant is an excellent example of mechanical inspection. Twenty-five different measurements must be checked by



Courtesy Timken Roller Bearing Company.

FIG. 103. Profilograph for Measuring the Smoothness of the Mirrorlike Surface of a Bearing. (A ray of light from a fixed source is directed through a tiny slot and focused on the mirror by means of a special lens. This ray is reflected by the mirror and strikes a sensitized sheet of photographic paper mounted on a revolving drum, thus automatically making a permanent record. As the diamond point moves up and down on its hinge, following the variations in surface finish on the specimen being examined, the mirror tilts and the ray of light moves up and down over the sensitized paper, leaving a record on the photographic paper.)

this machine. If any of these measurements made by the machine exceed the plus or minus tolerances of 0.00025-inch in some places and 0.0001-inch in others, the spot is marked and the shaft is discharged through a chute separate from the approved camshafts.

Another illustration of the application of scientific knowledge and mechanical ingenuity is the device used by the Timken Roller Bearing Company of Canton, O. Figure 103 graphically portrays the Timken Profilograph. By the use of this Profilograph, using a ray of light, variations in surface finish can be accurately measured in terms of a millionth of an inch (0.000001″.)

3. *The X-Ray.* The X-ray machine is usually associated with the medical or dental profession or the research laboratory. In recent years its practical manufacturing use has been demonstrated in detecting flaws in materials not discernible by ordinary visual or gauging techniques. Its most extensive use at present is in connection with the examination

of steel and iron castings and rolled steel sections for internal flaws. These defects can be detected before expensive operations are performed on these parts.

4. *Electrical devices.* Electrical test sets are used extensively in the electrical and automotive industries. Their prime purpose is to test the electrical characteristics of a component part or to check the proper action of the final assembly. In the electrical industry, for example, they are used to check the proper winding of armatures and field cores. The stroboscope is a device which enables an inspector to study the action of an object moving at high speeds to determine any irregularities due to vibrations, eccentricities, or defective parts. By its use a given tooth of a saw revolving at 7200 cycles per minute can be studied as if it were standing still.

5. *Laboratory equipment.* Almost every type of laboratory equipment is used in industry somewhere for inspection purposes. Chemical analyses of almost every description are used in some process controls, as also are tests for physical characteristics such as hardness, tensile strength, etc. The steel industry makes use of both types of tests. The rubber industry, particularly in its compounding and curing operations, makes extensive chemical tests.

PART V

PERSONNEL RELATIONS

CHAPTER XX

THE ORGANIZATION AND POLICIES OF A PERSONNEL DEPARTMENT

Most employers have clearly recognized the need for some procedure to maintain the close personal relationships between the worker and the management that prevailed under the small shop owner. This situation presents a real managerial problem to large enterprises. The larger the enterprise the more difficult it becomes to maintain a close relationship between the policy-forming executives and the man at the bench. Many a sound personnel policy formulated by the major executives would scarcely be recognized by these same executives should they see its transformation in the process of being passed down the line organization. In all discussions of personnel relations it should ever be kept in mind that *the most effective personnel relationships are those which naturally grow out of the work situation* and that the personnel department's major function is to promote a harmonious environment for the worker.

Definition of labor policy. A personnel policy may be defined as that body of principles and rules of conduct that governs the business enterprise in its relationship with its employees. They are a fundamental part of the basic business policies that guide the organization in the achievement of its major objectives. The more clearly these major objectives are outlined, the more specific will be the personnel policies, both in statement and operation. Personnel policies like business policies in general are dynamic, changing to meet the current situation. While they are dynamic to meet fundamental changes, they nevertheless should possess a large measure of stability.

Characteristics of a personnel policy. As stated above, the sound personnel policy avoids opportunism and is essentially stable, having due regard for the human equation. In the long run, personnel policies will not be sound unless the organization policies are likewise sound. A successful business enterprise possesses organic unity of purpose. A

weakness in any function weakens the entire organization. The objectives of an enterprise are naturally influenced by many considerations: competition, tradition in the particular industry, technological development, social approval, the prevailing attitude of labor, governmental controls, and the ideals of the entrepreneurs. In the light of our present business *mores* a sound personnel policy should in general possess the following characteristics:

1. It should recognize individual differences as to capacities, interests, ambitions, emotional reactions, desire for security, etc.
2. It should recognize the current trend toward group action and a tendency to seek a voice in those phases of management in which the worker is vitally interested. (Management should not be blinded by collective bargaining to the fact that individual differences are important. A worker or a group of workers may feel as lost in a large union as when they had no formal recognition whatever.)
3. It should be definite. Ambiguity and uncertainty are destructive of plant morale.
4. It should be stable yet possess sufficient flexibility to meet changing conditions and the varying needs of individuals.
5. It should be an integrated part of other basic company policies. The lack of organic unity results in confusion.
6. It should provide adequate means for becoming generally known and understood by all interested parties.
7. It should give due regard to the interests of all parties, the workers, the public, and the owners of the capital.

The extent and nature of personnel policies. The nature and extent of personnel policies varies with the individual enterprise. Some activities are basically of a personnel nature and yet for organization reasons are classified under other than personnel departments. A study of published reports of some twenty large corporations shows the following activities that may reasonably be classified as an expression of their personnel policies. No one company had all of these activities, yet at least one company was engaged in such program.[1]

1. Cooperation between employees, management, the community, and the consumer.
2. Hiring of employees.
3. Conditions of employment.
    a. Method of wage payment.

[1] See J. E. Walters, *Factory Management and Maintenance*, Feb., 1938, pp. 71-79, "Putting Labor Policies on Record," for an excellent discussion of this subject.

b. Hours of work, overtime, rotating shifts.
c. Promotion, discharge, lay-off, rehiring.
d. Guaranteed employment after establishing certain seniority rights.
e. When employee is considered a regular employee.

4. Procedure for handling grievances.
5. Safe practices and compensation for employees injured while on duty.
6. Financial aids.
   a. Insurance.
   b. Savings and loans.
   c. Credit unions and mutual benefit associations.
   d. Profit-sharing.
   e. Payment of part or all of tuition for school attendance or correspondence courses.
7. Rewards for suggestions.
8. Social security.
   a. Unemployment compensation.
   b. Pensions and annuities.
9. Educational programs.
   a. Apprentice training.
   b. Preparation for promotion.
10. Health, hospitalization, and similar activities.
11. Company stores where employees may buy company products.
12. Vacations with pay.
13. Pay allowances while absent on account of illness.
14. Freedom of discussion with management.
15. Collective bargaining.
    a. Recognition of employees' rights under the National Labor Relations Act.
    b. Recognition of a particular bargaining agency where one has been recognized.
    c. The right of individuals to be heard individually.
    d. Management's interpretation of collective bargaining and the items concerning which collective bargaining is designated.
16. Procedures for carrying out company policies.

Methods of interpreting personnel policies to employees. Personnel policies to become effective must be known and understood by all parties concerned. Sound policies promulgated by management or formulated cooperatively with representatives of the employees will function smoothly for the most part in proportion to their understanding

and acceptance by the rank and file workers and their immediate supervisors. Where the organization is relatively small these policies can be readily communicated in person or by the use of the bulletin board. The actual practices and rights of interested parties become accepted customs and later traditions. Even under these simple conditions the problem of initiating new employees into the organization remains a difficult one. With the increase in the size of organizations the problem of mutually understanding personnel policies becomes increasingly greater.

To facilitate the transmitting of personnel policies to interested parties, to avoid as far as possible misinterpretation, and to give an increased stability to these policies, many corporations have deemed it wise to publish a statement of their programs. This practice has been gaining in acceptance since the World War and has received increased impetus since the beginning of the depression in 1929. A few of the many outstanding companies that have published statements of company personnel policies are the General Motors Corporation, the American Rolling Mill Co., Socony-Vacuum Oil Co., Inc., the Proctor & Gamble Co., and Marshall Field & Company.

How large must a business enterprise be to justify a separate officer responsible for personnel relations? There is no unanimity of opinion regarding the number of employees that will justify the employment of a full-time personnel director.[2] Some early writers on the subject stated roughly that an organization should have from 800 to 1000 employees to justify this functionalization. A large manufacturer with plants in many parts of the United States held to the policy of having a specialist in personnel in all of its plants numbering more than 500 employees. Recently it experienced a long and bitter strike in one of its Eastern plants having only 400 employees and a manager in whom the company had implicit faith regarding his skill in handling men. A post mortem convinced the central management as well as the local manager that sufficient care had not been given to the personal relationships with the men. Needless to say, this plant now has a full-time man devoting all his time to the personnel aspects of management. The local manager, himself, asked for this additional functional officer. Recent trends in labor legislation have added to the work that must be done by some agency of business. This may well be assumed in the case of smaller organizations by the personnel officer and thus justify a full-time man in an organization that formerly might have felt it an unnecessary expense.

[2] The terms, *industrial relations department* and *personnel department*, are used interchangeably in industry. In the merchandising field the accepted term is the *personnel department*.

Organization of the personnel division. The industrial relations department or personnel department, whichever name is used, is charged with the responsibility of maintaining harmonious relations between employees and employer within the framework of the established policies. The industrial relations activities by no means replace the responsibilities of the line executives, but merely supplement them. The industrial relations department is a functional department as far as the entire organization structure is concerned.

The various functions of the industrial relations division may be classified as follows:

1. Maintaining an adequate labor supply—employment.
    a. Selection and placement.
    b. Promotion and transfer.
    c. Layoffs, rehiring, retiring, and discharge.
    d. Records and research.
2. Education and training.
    a. Instruction and company policies.
    b. Job instruction—apprentice training, vestibule schools, instruction on the job, etc.
    c. Foreman and executive training.
    d. General industrial education.
    e. House-organ and library facilities.
    f. Americanization.
3. Maintaining satisfactory personal contacts and employee relationships.
    a. Job analysis, specifications, and rating.
    b. Employee ratings.
    c. Wages and rewards.
    d. Shop rules and regulations.
    e. Labor audit.
    f. Employee records and labor statistics.
    g. Regularization of employment.
    h. Adjustment of individual grievances.
    i. Labor turnover.
    j. Suggestion systems.
4. Maintaining satisfactory group relationships.
    a. Contacts with employees' representatives.
    b. Contacts with employers' groups.
    c. Contacts with governmental agencies.
    d. Contacts with community agencies.
5. Maintenance of employees' health.
    a. Initial physical examination and periodic examinations.

b. Treatment for minor injuries and diseases.
c. Hospitalization.
d. Sanitation, health education, and mental hygiene.
e. Rest periods, recreation, and general counsel.

6. Maintaining a safe place to work.
   a. Safety guards and inspection of equipment.
   b. Safety programs and educational activities.
   c. Fire protection and police activities.
   d. Safety records and workmen's compensation for injuries.
7. Service activities (sometimes erroneously called welfare work).
   a Credit unions, savings and investment plans.
   b. Social and recreational activities.
   c. Housing programs.
   d. Company stores, restaurants, etc.
   e. Advisory services, legal aid, hospitalization programs for employees' families, etc.

The size of the business enterprise will influence to a great extent the actual physical organization of the industrial relations division. In a small enterprise many of the functions listed above will be combined in the same person. In a very small business these functions may be carried on by the plant superintendent, secretary, treasurer, chief clerk, or some other person. In a large organization use is frequently made of the Advisory Committee on Industrial Relations. Under such an organization the Director of Industrial Relations usually acts as the secretary or chairman of this committee.

Western Electric Company, Inc., Fig. 104, portrays the organization of industrial relations at the Hawthorne Works of the Western Electric Co. There are three main divisions, placement, research, and employee service. This chart is so complete that it requires little comment other than to say that this organization is an outstanding leader in personnel research. Figure 105 illustrates another division of the Western Electric Company that deals with employees. It will be noted that safety and health activities are in the Public Relations Department.

The field of the personnel department. Plant morale is so intangible and its development so difficult that it was not until the growth of the personnel department in industry that most concerns paid any conscious attention to it. Many personnel departments, mechanistically conceived, have gone about the various phases of their work without seeing their relationships to this most vital factor. The personnel department that has for its object only the hiring of the worker, his training, and the supervision of the workers' activities that do not deal directly with production, has not begun to visualize its task. This department must take

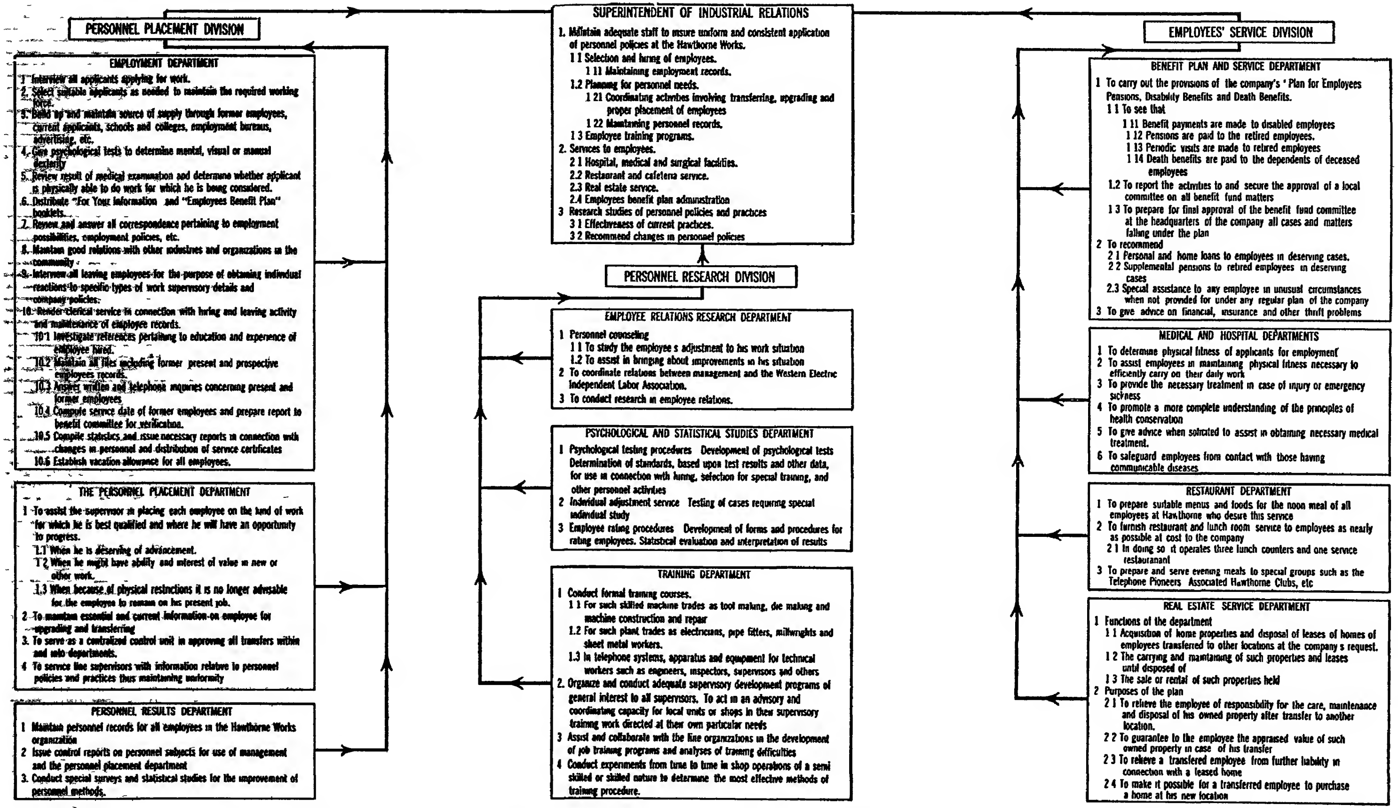


FIG. 104. Functional Organization Chart of the Industrial Relations Branch, Hawthorne Works, Western Electric Company, Inc.

the productive process as it finds it, and develop, with the aid and cooperation of the production executives, this intangible thing, plant morale. It must seek ways and means of looking at the plant through the eyes of the worker, in order that it may take steps to eliminate, either directly or with the cooperation of the general and production management, those factors which are the cause of the failure of the workers to cooperate.

The personnel department is that section of an organization that can be continuously looking at operations from the viewpoint of the worker. And, regardless of its own particular method of organization, this is its primary reason for being. To organize a personnel department does not imply that line executives may cease to think of the workers' point of view. It merely means that there is in the organization a department

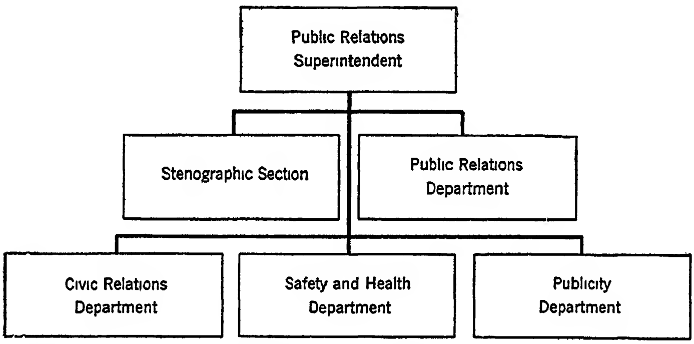


Fig. 105. Organization of Public Relations of Hawthorne Works, Western Electric Company, Inc.

which will now continually bring the workers' point of view to the line executives. Neither does the creation of a personnel department relieve the general management of the necessity of considering major policies with the workers' point of view in mind. No personnel policy will succeed which does not have the original and continuous backing of the general management. It is the function of the personnel manager to keep the general management in constant touch with the pulse of the workers, and to guide them toward decisions which will make for wholehearted cooperation of the workers. It is a task of the personnel department to prove to the worker that he is not a cog in the machinery of production, but rather a vital section of the machine, regardless of how small his share in the productive process may seem to be.

The most effective way in which the personnel manager and his department may assure the worker of their interest, and that of the firm as a whole, in his problems is an intangible one. It rests largely on their general attitude. To secure the cooperation of the workers on the basis of such an attitude is a gradual achievement and one that is gained

through effective handling of particular situations. There are many ways for a personnel department to work toward this aim, but, regardless of particular ways which may be described, the most effective methods will occur to the personnel staff at particular times and under particular conditions.[3] One primary step is to provide for the hearing of any complaints with reference to wages, treatment, or conditions, to investigate these complaints, and to endeavor immediately to adjust them and prevent their recurrence. Although it is fundamental that the personnel department shall thoroughly understand and be sympathetic with the employee, in this relationship they must not forget their obligations to the production forces nor the requirements of production.

The proper position of the firm in the life of the employee. One of the phases of personnel policy on which there can be much honest disagreement is the position of the company in the life of the employee. Paternalistic concepts of the employer-employee relationship cannot help but destroy morale, and yet the personnel department must stand ready to cooperate with any outside interests, municipal or private, which may be taking steps toward general betterment of social conditions within the community. It is a peculiar fact that the more the personnel department works with problems of morale development,[4] the more likely it is to extend into paths and methods of activity which lead in the direction of paternalism. The type of work within the plant and within the community which has the greatest possibilities for the development of industrial good will has also the greatest possibilities of paternalism if not founded upon a sound economic, sociological, and psychological basis. The employer must ever be on the alert to avoid doing something out of normal human sympathy which will later react disastrously. The same desired end can usually be attained, possibly with less despatch, by working through the employees rather than by direct action on the part of the employer.

Some plants, located in communities which are unable to provide amusement for their citizens because of their size or remoteness, frequently find it necessary to provide living and recreational facilities for their employees in a manner which may smack of paternalism. This may not prove pernicious, provided it is properly handled. What must be avoided are plans indicating that the company feels it controls the entire life of the worker, merely because it is his employer.

Critics of misguided yet sincere efforts of employers in the past to

[3] See Chapter XXII, page 305, for a description of the Armstrong Cork Company's method of determining employee attitude.

[4] Factually plant morale is a by-product of satisfactory relationships of the employee in his work unit. Many attempts at morale development defeat their own objectives, by making the desired end too obvious.

serve their employees often underestimate the influence of the company in the lives of its employees. In this connection it is well to interpret what is meant by the term, "company." As a legal concept it exerts very little if any tangible social influence upon the worker with the possible exception of its being a symbol of ownership of the property. In this sense the right in property is frequently held very lightly. To steal or pilfer from a corporation usually does not carry to the worker the same social disapproval as stealing from an individual. The company as represented by the officials is real to the workers in just about the same ratio as their personal contacts with these officials. Usually the "boss" is the management as far as the individual worker is concerned. The company as a group of persons working toward an objective of producing a given product is in a very real sense a vital living social as well as economic organization. The effective unit is usually the departmental organization as far as social influence is concerned. There is both an official and an unofficial organization. The official organization is represented by the managerial controls, while the unofficial organization consists of the voluntary social structures that naturally take shape when groups of people are thrown into intimate contact with each other. The personal satisfactions derived from membership in the business group will be determined in part by the homogeneity of its membership. Not infrequently there may be several groups within a department, based somewhat upon race, religion, fraternal affiliations, age, sex, etc. Unless the social prejudices are too strong the social group will cut across many barriers to draw individuals with like tendencies together. It is very common indeed, particularly among people of the same general age group, to find the social life of the members of a work group intimately interwoven. This is especially true in the smaller cities, but the same tendency holds in the city of Chicago.[5] The company in the sense of those collectively employed under a given management bulks large in the lives of the employees. They use the term, "we," when referring to their activities.

[5] See William J. Dickson, "Policy With Reference to Performance Standards," *Elements of Labor Policy*, Bulletin No. 7, Bureau of Industrial Relations, University of Michigan, 1938, pp 35-38, for a discussion of the worker reaction to his work-social situation at the Hawthorne Plant of Western Electric Company.

CHAPTER XXI

ORGANIZED LABOR AND MANAGEMENT

The attitude of organized labor to modern industrial management has changed very greatly in recent years. At first actively hostile to some of the fundamental principles of scientific management, certain groups of organized labor now heartily indorse and take as their own basic policies some of those management ideas which their earlier leaders fought. Prior to the National Labor Relations Act (The Wagner Act) employers as a group in most of the large-scale mass production industries were actively opposed to collective bargaining with an outside labor organization. Up to April 12, 1937, when the Supreme Court sustained the constitutionality of this act there was much opposition to bargaining with labor unions, although a few of the key industries such as some of the automobile manufacturers, and big steel companies had signed contracts with affiliates of the C.I.O.[1] In those industries which are sufficiently organized to support trade agreements, it has been seen that organized labor and management are now progressing hand in hand toward lower production costs.

Early organized labor opposition. The early opposition of organized labor to modern management's principles and devices was partly based on economic principles, since repudiated, and partly on a misunderstanding of its basic concepts, arising out of the improper wording of the first scientific management writings. Notwithstanding his many denials, it is probable that most union leaders who were contemporaries of Frederick W. Taylor thought that he was an enemy of unions. In Taylor's day, many unions favored restriction of output to which Taylor's whole life was opposed. Today many groups in organized labor in the United States agree that in increased output lies the opportunity for higher wages.

It was probably due to the fact that scientific management first developed in unorganized trades that union leaders of the time feared it and endeavored to destroy it. They particularly attacked time study as the device which they claimed was symbolic of the attempt of scientific

[1] Congress of Industrial Organizations, formerly Committee of Industrial Organization, is a federation of industrial unions in contrast to the A. F. of L. which is composed largely of craft unions.

management to destroy skill and initiative. Against time study organized labor made a great drive in Congress in 1912 at the hearings before a special committee of the House of Representatives "To Investigate the Taylor and Other Systems of Shop Management." Stop-watch time study had been adopted in the arsenals of the Army Ordnance Department through the leadership of General William Crozier, Chief of Ordnance. It is probable that there were more workers working under rates set by time study in the government arsenals in 1912 than in any other enterprise. However, it was the example of the use of the stop-watch in the new and unorganized automobile industry that led the unions to try to destroy its use nationally by prohibiting its use on Government work.

It was during these hearings that Taylor was put on the stand and said, "Do not understand for a minute that I am opposed to trade unions. . . . I am in favor of them. They have done a great amount of good in this country and in England; I am heartily in favor of those elements of trade unions which are good. . . . I believe that the unions are misguided in a few respects. . . . One of the worst principles of the trade unions . . . is that it is to their interest to deliberately, purposely work slow instead of working fast, with the object of restricting output." Taylor's attitude of yesterday has become the attitude of *enlightened* union leaders of today. It will be observed that this last statement emphasizes *enlightened* leadership. Unfortunately all union leaders as well as managerial leaders are not enlightened. There still are many cases of deliberate restriction of production or output.

The objections of labor to time study. Many of the objections that labor has held against time study have been justifiable, in view of the methods used in some companies. In cases in which the management has wished to engage in time-study work on a scientific basis, they have been unjustifiable. Back in 1912, under the pressure of labor union lobbying, Congress wrote into an appropriation bill a provision that forbade spending of the federal funds for time study. During the following quarter of a century it has been the general opinion that both management and labor leaders have acquired a more comprehensive understanding of social objectives and means of attaining them. Several unions have used the technique of time and motion study as an aid in fact finding to strengthen their hands in collective bargaining; management has made extensive use of time and motion analysis in discharging their responsibilities.

The published attitude of three unions regarding scientific management techniques in summary form is given below:

1. The Steel Workers Organizing Committee in Publication No. 2, *Production Problems* (1938) on page 10 state their position as follows: "There

is often dispute between management and men as to what is a fair day's work. Men may complain of speed-up. The management charges that the men are lying down on the job. The way to settle this kind of dispute is to set production standards by agreement.

"How is this done? First make sure that tools, materials and work are assigned so that work flows through the shop with little interruption. Then take a man doing a given operation and tell him to work at his ordinary speed, without soldiering on the job, but still in a way that is not too fast to keep up without strain or fatigue. A representative of the union and a representative of the management should watch him and measure his speed. There are various ways of doing this that provide the required accuracy and precision.[2] There should be agreement about the results by both sides. Observation may be repeated several times, or made for a number of men doing the same job. On the basis of the records obtained, *and after* consultation with those doing the work, it may be agreed how long it ought to take to do the operation in question, and how many times it ought to be done per hour or per day. Such an agreement then is adopted as the *production standard* for the job in question. . . ."

2. Emil Rieve, President of the American Federation of Hosiery Workers writing in the February, 1939 issue of *Labor Information Bulletin,* p. 6 states, "One of the most important features in the union's agreement with the Full-Fashioned Hosiery Manufacturers' Association has been the operation of an impartial adjustment machinery. The impartial chairman who is selected by the union and representatives of the manufacturers, handles all grievances that cannot be satisfactorily settled by direct negotiation. He is also responsible for making wage studies and for helping to fix wage rates as new technical developments occur in the industry. Wages are based upon complicated piece rates which vary with the skills required, speed of machines, amount of hand labor involved, quality of silk, and numerous other factors."

3. Anne Gould of the International Ladies' Garment Workers' Union in the April, 1938 issue of the Labor Information Bulletin, page 2, in an article entitled, *Fixing Wage Rates in New York Dress Industry* reports, "Several years before the old agreement expired the Dressmakers' Union hired a number of industrial engineers to study the labor factor of the industry with a view to reduce the various jobs involved in making dresses to measurable units. This study resulted in the unit system, which is a method of expressing the average time required for each operation in the making of a given dress. By this method the job-time units for certain operations which are common to all garments have been established. The unit system is today used as the yardstick by which piece rates are determined because the tremendous style variability makes standardized piece rates impractical."

[2] Those familiar with these methods recognize time study by the use of a watch or by the use of a motion picture as being two of the most practical methods. A third method is the use of elemental times if they have been accumulated. (This footnote is the author's and not a part of *Publication No. 2, Production Problems.*)

It is evident that there are some marked contradictions among labor leaders regarding the use of the tools of scientific management. The objections of labor to time study may be classified under these main headings: objection of its effect on the status of the individual workers; objection because of its effect on basic union policies; and objections because of defects of method.

Effect on status of individual workers. It has been pointed out by many workers that to take time studies of a worker is, in a sense, an evidence that management is suspicious of the fair intentions of the worker to turn out a fair day's work. It is contended that management would never think of taking time studies of executives in the performance of their jobs, but that more opportunity is usually afforded for bettering their output than for bettering the output of the worker. As in the case of most other objections, the answer to this depends on the methods of taking the study, the extent of cooperation of the worker himself, and the benefits which the worker achieves.

It is also pointed out that time study is destructive of the worker's skill, inasmuch as it substitutes the skill of the management for the acquired trade skill of the worker. Not only may this result in the degradation of the worker, but it is to be questioned whether it is desirable from the broad social standpoint to allow one small class in the industrial community to have all the knowledge concerning how jobs should be done. In this connection, job study is frequently referred to as a means of making the worker a portion of the machine, that portion which has not as yet been cast into steel, and thus repressing his initiative. It is pointed out that after job studies, workers must conform to the methods of others. Of course the answer is that although it is true that all workers are taught the one best known method at the time, it is not true that workers are prevented from improving upon the best known method of the time; rather, they are encouraged to do so.

It has frequently been said that, although rates under job study may be guaranteed, nevertheless time study becomes a method of cutting wages. The reasoning is that the reservation is always made, on guaranteeing wage rates, that a change in the method of operation may result in a change in the rate. Since the method is so clearly and closely detailed by the result of job study, it becomes exceedingly simple in some slight degree to change the operation. This change may be brought about because of the high wages which workers may have been getting through close application to their work under the assurance that rates will not be cut; but the operation is slightly changed and the new rate which is set may be sufficiently below the old rate to make it necessary for the worker to apply himself at the pace he has achieved and, at the same time, to receive considerably lower wages. Again, the only

answer which can be made to this objection is that no management that wished to continue job studies over a long period of time, or wished to maintain good relations with its employees, would ever attempt any such practice.

Time study is opposed to fundamental policies of trade unionism. Trade unionism is, of course, based on the idea of the development of class consciousness among workers as a group. This is necessary in order to combat the superior economic position of employers, particularly organized employers. Time study, which results, to an extent, in competition between the abilities of individual workers, naturally has a tendency to break down this class consciousness. This is particularly true inasmuch as the rates based on time study ordinarily are piece rates or some variation of these. Traditionally, unions in general have not been very favorable toward piece rates. As pointed out above, however, there have been some very successful unions that have adopted piece work as their system.

It is probably true that a study of jobs within an organization has a tendency to knit the organization into a unified whole of management and workers, all striving to better the general condition of a particular plant rather than any particular group in industry as a whole. In so far as this is true, it is but natural that organized labor should look with some degree of alarm upon the time study, particularly since this violates one of the basic ideas behind the development of unions. On the other hand, the adoption throughout an industry of standardized piece rates, as in the case of the International Ladies Garment Workers' Union, builds up the same unity among the group as the flat day rate and protects even in more detail the exploitation by a few employers.

Unions and low-production costs. Basic trade-union utterances with reference to employer-union cooperation have already been noted. William Green has said,[3] "Labor realizes that the success of management means the success of labor. For that reason labor is willing to make its contribution to assist management and to bring about the right solution of problems dealt with by management. . . . Management is understanding more and more that economies in production can be brought about through the cooperation of labor and the establishment of sound labor standards rather than through autocratic control and the exploitation of labor. Labor is understanding more and more that high wages and tolerable conditions of employment can be brought about through excellency in service, the promotion of efficiency, and the elimination of waste."

A Conference for the Elimination of Waste in Industry was called

[3] *Labor's Ideals Concerning Management*, by William Green, President, The American Federation of Labor, Bulletin of the Taylor Society, Vol. X, No. 6.

by the Labor College of Philadelphia and the Central Labor Union of Philadelphia on April 9 and 10, 1927. This conference, drawing union leaders from all parts of the country, marked a new page in labor-management history. It was addressed by leaders of labor and management, and the dominant note was set forth by President Green, as follows: [4] "Economies in production are a concern of all who have a part in the work and who may benefit from increasing the margin between costs and selling prices. Initial responsibility for efforts to reduce or eliminate wastes rests upon the management, while unions contribute to the development of plans and in putting plans into production procedure."

At the Waste-Elimination Conference, Mr. Gustave Geiges, President, Full-Fashioned Hosiery Workers No. 706, gave an address which typifies the attitude of the new union leadership toward modern management. He said in part: [5]

> "Wages in the full-fashioned industry probably will average higher than in most industrial occupations today, but the labor cost of a pair of stockings is low. The proportion of the cost of a stocking which goes into labor is about 25 per cent of the price at which the manufacturer sells his goods to the wholesaler. . . . It is vitally important that goods of the highest quality be turned out in the full-fashioned factory in order that the highest profits be realized. . . . If the knitter is making good stockings he is also making a lot of them, and, therefore, is making a good wage. And when he is making imperfect work he is losing money just as well as the manufacturer is losing money. . . . That efficiency and waste elimination really pay in our industry has been proved to the satisfaction of many. Those concerns, such as the Phoenix of Milwaukee, and the Gotham, Lehigh, and William Brown companies of Philadelphia, which are among those concerns making the highest profits, are firms which co-operate with the union, and which often pay above the union scale of wages in their different plants. . . . The official policy of our organization is to encourage capacity production, although, of course, we stress the fact that the worker must not speed up to the point where he produces a contrary reaction on his health. . . . We have gone into certain shops . . . where production has fallen off. We investigated and found out why our people were not doing their best work and we stimulated the sense of workmanship in those groups of workers who had become indifferent for various reasons. Production in all cases increased. . . . We believe that we can reduce waste of all kinds most effectively by developing an understanding among the workers in the industry that proper use of material and sense of responsibility in each and every worker in the full-fashioned hosiery industry toward his industry and his union will bring about an enormous conservation of human effort and expensive material, at the same time cutting down running costs and adding to profits and wages."

[4] *American Federationist*, Vol. 34, No. 6, p. 664.
[5] *Ibid.*, p. 668.

Other statements of union attitudes are as follows:

> "In order for all our people, wage earners, farmers and other useful people, to have more, we need to produce and distribute more, not less. . . . We have trained management and millions of wage earners able and willing to work. Under such circumstances greater production, guided by efficient management, means lower cost per unit. Lower costs tend toward lower prices. This enables our people to buy and use more goods. This, in turn, makes possible putting our unemployed back to work. With little or no unemployment the bargaining power of labor is increased, resulting in higher wages. Higher wages coupled with lower prices mean a higher standard of living."[6]
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> "Almost from its birth the International Typographical Union has been called upon to deal with grave and complicated problems brought about by the rapid development of machinery in the printing trades. Instead of condemning or fighting the machines, the International Typographical Union very early in its history adopted the policy of accepting them as an indication of progress in the industry and of concentrating on obtaining for its members a fair share of the benefits resulting from their use."[7]
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> "The union [Full-Fashioned Hosiery Workers] has been constantly aware of the importance of technological and economic trends in the industry and has never opposed the introduction of new and more efficient machinery. . . . The union realizes that if the older sections of the full-fashioned hosiery industry are to compete with manufacturers in the recently developed and for the most part non-union areas they must be able to install up-to-date equipment."[8]

Maintenance of good working conditions in industry. The union viewpoint is that, while unions always carry on for the protection of the workers, favorably disposed employers may sell out, or, because of pressure, be unable further to carry out the liberal policies that they have instituted. As the years pass on, doubtless there will be an increasing number of such cases, although, in number, they will be far outweighed by the new companies pursuing a liberal and enlightened policy toward their workers. Nevertheless, the dangers which are pointed to by the unions are real dangers, to be given every consideration in the formation of works councils and pension and group-insurance plans.

The National Labor Relations Act and the worker. The main objective of the National Labor Relations Act, after being stripped of all surplus verbiage, contained in its statement of purpose is the guarantee to the workers of the right to organize into groups of their own choosing

[6] Steel Workers Organizing Committee, *Production Problems*, Publication No. 2, 1938, p. 1.

[7] Boris Stern, *Labor Information Bulletin*, Nov. 1938, p. 4, "The International Typographical Union."

[8] Emil Rieve, President of American Federation of Hosiery Workers, *Labor Information Bulletin*, Feb. 1939, p. 6.

for collective bargaining. The act in this respect gave the workers nothing new. It did, however, provide protection to the workers against discharge because of the exercising of this right to membership in a union. Under the act an employee is protected against discrimination because of his union membership. He is further protected from the annoyance of any attempt on the part of the employer to influence his choice of union. The act does not protect an employee from annoyance, intimidation, or violence on the part of a particular union seeking an employee's membership or dues. The act, as it has been interpreted, deprives the employee of the friendly counsel from his employer relative to a given union, even though it be sought voluntarily by the employee. (There is nothing in the act itself that needs to be interpreted as an unfair labor practice on the part of the employer to advise his employees adversely when they seek his advice regarding the joining of a particular union, but the N.L.R.B. seems to be inclined so to interpret the act.) The individual employee has practically no rights under the National Labor Relations Act unless he is a member of the majority bargaining group. The act sanctions a closed shop provided a majority acting through their recognized bargaining agency can persuade the management to sanction such an arrangement.

The National Labor Relations Act and the employer. The National Labor Relations Act, sometimes called the Wagner Act, was designed to protect the employee in his right of collective bargaining. It confers no rights upon the employer; however, the act takes away from the employer no rights that he should have ever exercised from the standpoint of long-run industrial statesmanship or social and economic well-being. As the Act has been interpreted, however, it has taken away from the employer certain rights, a few of which are as follows:

1. The employer's right of freedom of speech is definitely curbed with respect to answering his employees' queries if his remarks may be interpreted as influencing their membership in a union.

2. The employer may not solicit his employees to return to work when such action is calculated to break the ranks of workers legitimately on a strike.

It will be noted that these limitations of the employer's acts apply only to those activities that may be interpreted as having a bearing upon union membership or collective bargaining.

The employer under the Act still may hire any man of his choice (provided he does not have an agreement with the union to the contrary), promote the man he desires, or discharge a man for cause—other than union membership. In other words, under the National Labor Relations Act, itself, the employer is restricted in no activities other than those affecting collective bargaining. In the Board's efforts to make the law

effective it has gone to some extremes that do not seem necessary even to many friends of the Act. The Supreme Court reversed the order of the Board in the case of the Fansteel Metallurgical Corporation, where the Board sought to force the company to rehire some sit-down strikers who were legally discharged. It is to the credit of the Board in this case that it did not justify the sit-down strike, but claimed the right to take the steps it ordered as a method of enforcing the provision of the act

CHAPTER XXII

EMPLOYEE PARTICIPATION IN MANAGEMENT

Employee participation in management has been one of the significant developments in the growth of personnel departments. Participation has meant at times a share in the profits of the enterprise, but more correctly, and increasingly, it has meant an employee voice in the determination of management policies, in so far as they affect employee interests. To understand thoroughly the evolution of this idea in industrial operation, it is essential that it shall not be regarded wholly in the light of the structure of any one of its forms of expression. The form is not important. The basic idea is. There has never been found as great an incentive for carrying on industry as private ownership and the mental attitude toward private property owned or to be acquired. Employee participation in management seeks to extend to all members of the enterprise such a share in its operation that the satisfactions of private ownership will be extended throughout the working force. It is the hope of the advocates of employee-employer cooperation to develop a feeling of *oneness,* a recognition of mutual interest, and a desire to carry on which is frequently described as "loyalty to one's own best interest." This is undoubtedly an optimistic approach and the results are seldom fully realized, yet the efforts in this direction mark a distinct advance in labor relations.

Employee participation in profits.[1] The first and oldest form of employee participation is direct participation in the rewards of the business. In substance this was practiced in the days of an agricultural economy when the tenant cultivated the soil on the "shares" basis. This practice still prevails in our rural sections today. The sharing of the crop idea in agriculture has been supplanted in industry first by a financial wage and later by a wage plus a financial share in the profits of the enterprise. This has come either through some developed plan of profit-sharing, or through melon-cutting at the end of prosperous years. Profit-sharing implies an agreement between the employer and the employees, under

[1] See Senate Report No. 610, 76th Congress, 1st Session, *Survey of Experiences in Profit Sharing and Possibilities of Incentive Taxation.*

which the latter receive, in addition to their wages, a predetermined share in the profits of the undertaking over a given period. Under profit-sharing, an employee knows at the beginning of a year that he is going to secure a very definite share of whatever profits there may be at the end of a year.

The distribution of bonuses at Christmas, or other times of the year, in the attempt to share with employees the profits of the enterprise over the period, has not usually proved a successful form of employee participation. It cannot in reality be called participation at all, since the distribution of the bonus is essentially a gift from the firm to its workers.

Profit-sharing is often used as a means of arousing the interest of workers whose work is such that it is difficult or impossible to place them upon piece-work. Such men are executives, delivery men, men in the shipping room, and, at times, salesmen. Then again, by arousing the sense of participation, profit-sharing is frequently used for some specific purpose in the business. Thus it may be used to prevent the waste of materials, as in the case where a concern agrees to split "fifty-fifty" with its employees any saving of material which is effected by them. It is regarded by many managers as an ideal way to reduce labor turnover, by providing that only employees of a certain minimum length of service shall share, and that these shall share in accordance with their length of service. Profit-sharing has been advocated as an ideal preventive for hasty strikes called without warning, if it be provided in the profit-sharing agreement that only those employees with continuous service shall share in the profits. Going out on strike was naturally interpreted as interrupting continuous service. This phase of profit-sharing has now largely been outmoded by the National Labor Relations Act which specifically protects the employees' rights, as an employee, while on a lawful strike. The whole philosophy of tieing profit-sharing to programs that have as an objective the weakening of collective bargaining is open to serious question. Labor unions have as a rule not been advocates of profit-sharing programs.

One of the main objections that employers have raised to profit-sharing is that it does not in reality involve financial participation, inasmuch as losses are not shared by those who share the profits. This unquestionably is one of the weaker points in any profit-sharing plan, but its importance varies with the basic thoughts which have prompted the plan. Thus some employers have come to feel that there is a wage for capital, just as there is a wage for labor, and that, in justice, all above a certain wage for capital should be distributed between capital and labor. Under this assumption, there would be no cause for workers to share in losses, provided only that some provision were made for their repayment prior to the workers again beginning to share in the profits.

Employees reactions to profit sharing. Management's objectives behind profit sharing may be summarized as follows:

1. To promote individual efficiency.
2. To promote general efficiency.
3. To develop a waste-elimination consciousness.
4. To encourage managerial efficiency.
5. To develop a proprietary attitude on the part of employees.
6. To provide a measure of security for employees.
7. To reduce labor turnover.
8. To foster industrial democracy.
9. To encourage mutual cooperation and understanding between the employer and employees.

Most of these objectives are socially desirable. Since practically all profit-sharing programs have been initiated by management, the question naturally arises—how do the employees feel toward profit sharing even before having tried it out? In order to test the sentiment of labor with reference to this subject, questionnaires were mailed to a large and representative number of employees of each of 104 industrial plants throughout the United States employing, in all, approximately 90,000 men, none of the establishments having a profit-sharing plan in operation.

The replies indicate conclusively that the workers, far from being opposed to profit sharing, are strongly in favor of it and that the majority have some appreciation of the problems of capital and desire to be fair and reasonable. The responses also indicate that a large portion of labor is more interested in providing for the future than in having the funds available for immediate disbursement.[2]

Employee stock-ownership plans. This feature of investing profit-sharing funds in stock of the corporation has in the past been one of the more usual features of profit-sharing schemes. Such a program leads to direct participation in management. Any such plan should be carefully guarded and explained to employees concerned, particularly as regards possible decline in market value of the securities. Furthermore, unless the number of shares which a given employee may own is considerable, the plan tends to become one for investment of the surplus funds of the employee, rather than one of participation in management. This is indicated by the tendency of employees to sell stock, if it be in their control, at times when the market begins to decline. A serious

[2] H. R. Rietz, Vice President ILG. Electric Ventilating Co., quoting the Senate Committee investigating Profit Sharing in the United States, in a speech before the Industrial Management Society, April 7, 1939.

objection to worker ownership is the fact that it frequently works in direct opposition to security.[3] Should he be forced to be laid off for a long period because of reduced production, it will usually happen at a time when the value of his stock will be declining as well as during a period when the dividend return will be low. Such a procedure also lacks the desirable characteristic of diversity. Stock-ownership plans are more successful as means of participation among salaried officers than wage-earners, as these are usually better able to see and understand the benefits and are usually in a position to own sufficient stock to arouse their enthusiasm for the scheme.

Employee representation—works councils. Real participation in management can usually be achieved better and without any "strings" by some form of worker-representation than by any form of financial participation. The object of employee representation is to substitute cooperation in operations for the antagonism that has been frequently felt necessarily to underlie employer-employee or management-employee relationships. Cooperation can be achieved frequently without employee representation, but this relationship is presumed to furnish a condition wherein cooperation is enforced on both sides. It provides a condition wherein either side will perforce get cooperation out of their dealings with the other, if they put it in. Usually cooperation follows confidence, and confidence comes easily if management shows representatives of the workers that the employer has the interests of the employees at heart. It frequently is necessary for some time to elapse before employees are convinced that the employer sincerely desires to work with employee representatives. Then a longer time is often necessary, after the plan has begun operating, to convince both sides that their interests are similar as regards effective operation of the plan.

Works councils provide a means for representatives of the employer and those of the employees to get together and discuss matters of common concern. They are formed on the basis of agreements between an employer and the employees of that business, and differ from trade agreements, or agreements between an employer or employers in a given industry and organized workers within the industry as a whole. Trade agreements will be discussed later. Works councils always consider questions of shop rules and grievances, and in addition they often handle questions of efficiency of operation and economies, and at times questions of policies. Works councils organized for the first of these purposes are likely to develop mutual respect and confidence between the interested

[3] See: Industrial Relations Section, Princeton University, *Employee Stock Ownership and the Depression*, by Eleanor Davis (1933); also *Employee Savings, Stock Ownership and Profit Sharing*, by Helen Baker (1937) for a detailed discussion of this subject.

groups and gradually extend their activities to include the broader operating economic phases.

Most grievances are petty matters allowing easy settlement, whereas uncorrected grievances soon come to be looked upon as an evidence of the general attitude of the company. The works council provides an organized channel through which these grievances may be brought up and promptly considered. For instance, the workers of a given department may feel that the time clock is inaccurate or needs repairs, and the foreman may not take the prompt action which they think is needed. If no means of airing such a grievance be provided, it can readily be interpreted as meaning that the firm is not desirous of having the workers earn the bonus which may be offered, and may thus be interpreted readily as an evidence of basic policy. With a shop committee or works council before whom the matter might be brought, the time clock would without question be repaired immediately.

If the power of works councils be extended beyond mere routine consideration of rules and grievances, they may well handle, together with the personnel department, matters of discharge. Rules relating to causes of discharge may be formulated by the works council and then administered by them. All cases where, after conference between the foreman and the personnel department, discharge has been decided upon, can be brought before the works council for consideration upon request of the employee affected. Such power, if granted, will do much to make the workers feel that they are indeed partners in the enterprise, but nevertheless such power must be granted only after the cooperation of the foremen has been secured, or discipline will be likely to suffer. With good foremen, the restriction upon their authority will not be likely to be important, because they will still have the power of administering any rules that have been laid down by the works council, on which they will be represented in some way, and proper administration of these rules will ordinarily be upheld every time.

If the powers of the works council are to be broadened, they may well include matters concerning settlement of base rates. That changes in rates and schedules of hours to be worked can be made without friction has been the experience of plants which have submitted such questions to their works councils for decision. In fact, many plants have found that when a reduction in rates is necessary, the works council provides the most satisfactory means of explaining these to the body of workers. In cases where layoff is necessary, the works council provides the most satisfactory method of determining just which workers should be affected. Some plants have developed the idea of presenting to works councils such matters of basic policy as the production schedule, inasmuch as this directly affects the amount of work to be available. This would

certainly not be advisable until the works council had been in operation for a long time and an experienced group of workers' representatives, who could appreciate the manufacturing and economic conditions involved, were members. Works councils may well consider routine matters relating to production, such as quality, scrap, safety, and general working conditions, when there are no grievances or special matters for attention at the meetings. To be effective, there must be regular meetings and not meetings called at long intervals, and these subjects form a satisfactory fill-in for the discussions.

Types of works councils. The three main types of works councils which are utilized are the "industrial democracy" type, the "shop committee" type, and the company union. The industrial democracy type of works council attempts to apply to industrial organization a method of passing laws and settling policy which is similar to the organization of the Federal Government. There are ordinarily three bodies provided as parts of the works council under this type. First there is the House of Representatives, which is composed of representatives of the workers; then there is the Senate, which is composed of representatives of foremen and department heads; finally there is the Cabinet, or representatives of the employer, usually major executives. Matters to be settled may be brought up first in either the House of Representatives or the Senate, in the form of a bill, and after the bill has been passed by both houses, it goes for approval to the Cabinet, where it may be accepted or rejected. If rejected, it goes back to the house which originated it for revision or abandonment. It has the advantage of clearly bringing in the department heads in the formulation of any decision, but is very unwieldy, and has sometimes been installed in a way which indicated that the firm was turning over considerable power of administration to the employees, which, in fact, is not the case, inasmuch as final veto rests with the employer's direct representatives. Another disadvantage of the "industrial democracy" type of representation is the lack of personal contact between representatives of management and the employees.

The shop-committee plan involves the selection of certain members of the works council by the employees and selection of certain members by the employer. These members usually sit together and their decision is usually final. If they fail to reach a decision, the conditions of the plan as a rule provide for an appeal either to a major officer of the company or to a neutral arbitrator. This close personal relationship between management and employee representatives is a distinct advantage over the "industrial democracy" type of representation. Under this plan there may be one committee for the whole plant, or there may be departmental committees selected by the workers of given departments. Departmental committees consider minor matters, such as grievances,

with representatives of the employer, and select workers' representatives to sit on the works council, which is an appellate body for such minor matters and a body of original jurisdiction in the more important matters that are considered.

Operation of works councils. The exact organization, qualification of voters, term of office of representatives, number of meetings, and other routine matters will naturally vary with the necessities of the particular organization and with the desires of those forming the works council. There are, however, some general conditions which seem to be tried and applicable in almost all cases. Voters for employee representatives frequently have to be employed by the company for a certain specified period, usually about three months. Employee representatives' qualifications are well illustrated by the provisions formerly in effect at The Intertype Corporation, Brooklyn, New York: "Every qualified voter twenty-one years of age or over, who speaks and writes the English language and has been continuously in the Corporation's service for one year prior to election shall be eligible as an Employee Representative from the department where he works."[4] The term of office of representatives is usually a year, with provisions, which cause the elections to be held at different times, and thus make impossible the entire overturn of a committee at once. Meetings are held at periods varying from one week to a month.

Most plans call for an equal division of voting strength between the employees and the employer in all cases except the industrial democracy plans, where this same feature is provided for in another way. Frequently it is necessary to pass actions by more than a mere majority vote, sometimes by a two-thirds or three-quarters vote. This provision makes for permanence in the decision reached, but it also causes a certain number of cases not to be settled by the works council, and thus makes important the final authority. Regardless of the provisions for final authority in actions of the works council, it is necessary that the general management keep itself informed of what is going on and take an active interest in the proceedings. If this does not occur, the works council is bound to fail. As a matter of fact, no form of collective relationship regardless of the form can relieve management of its responsibility to provide constructive and inspiring leadership.

It is clear that a works council will not be effective if it be organized in times of stress, when the workers are dubious of the attitude of the management and perhaps are about to strike. The workers naturally become suspicious when they see the shop committees being organized at such times because of an overnight zeal on the part of the employer for

[4] This program has been discontinued in the light of developments under the National Labor Relations Act.

"industrial democracy." The time to establish a works council is in fair weather.

Many managers have said that what the worker wants is not a partnership in the enterprise. What he wants is to be able to be certain of steady work at fair wages, with an opportunity for advancement. If he is given this, these managers say that he makes no demands on them for representation or participation in management. If a manager is sure of this, and if he is conducting his business in a way that attempts to make things fair for both the worker and the employer, it is very probable that, as yet, in that plant, it would be unwise to try the formation of a works council, and far wiser to continue the broad-minded policy of management along the old lines which have proved successful and satisfactory to all concerned.

The future of works councils. The future of the works council type of representation is unpredictable. Some worker management groups seem to be entirely satisfied with the arrangement. Many workers prefer this type of co-operation to outside organization where heavy initiation fees and regular dues are required. The trend (1940) seems to be away from the traditional works council, composed of representatives from both the management and employee groups, to the company union made up exclusively of a committee or committees of workers. The National Labor Relations Act and its administration seems definitely to have contributed to this trend. A few of the state labor relations acts have definitely outlawed the company union. Strong feelings exist on the part of company union members. Mr. Henry L. Nunn of the Nunn-Bush Shoe Company speaking before the Management Conference, State University of Iowa, March 31, 1939, stated in reference to their shop union, "Attempts of the C. I. O. and the A. F. of L. for affiliation have always failed. As one C. I. O. organizer said as he emerged from a meeting with the workers, 'It's not a union there; it's a religion.'" The same statement made in reference to the Nunn-Bush employees could be made regarding many of the so-called outside unions, or, as their members prefer to call them, "legitimate unions." To many of these trade union members their union affiliation is almost a religion. Between these two extremes lie the great bulk of American workers. It is possible for both the labor union and the company union movement to develop side by side. However, the current temper of the labor unionist and his active political interests do not seem to point in this direction. It should be pointed out in this connection that most social relationships among the English-speaking peoples are a matter of evolution and that many seeming inconsistencies have adjusted themselves in behalf of the greater social good.

Trade agreements. Trade agreements not only provide a minute description of basic wages, hours, working conditions, rules, and methods

of discharge, but often cover methods of performing operations. In the settlement of disputes they almost uniformly prescribe some neutral arbitrator.

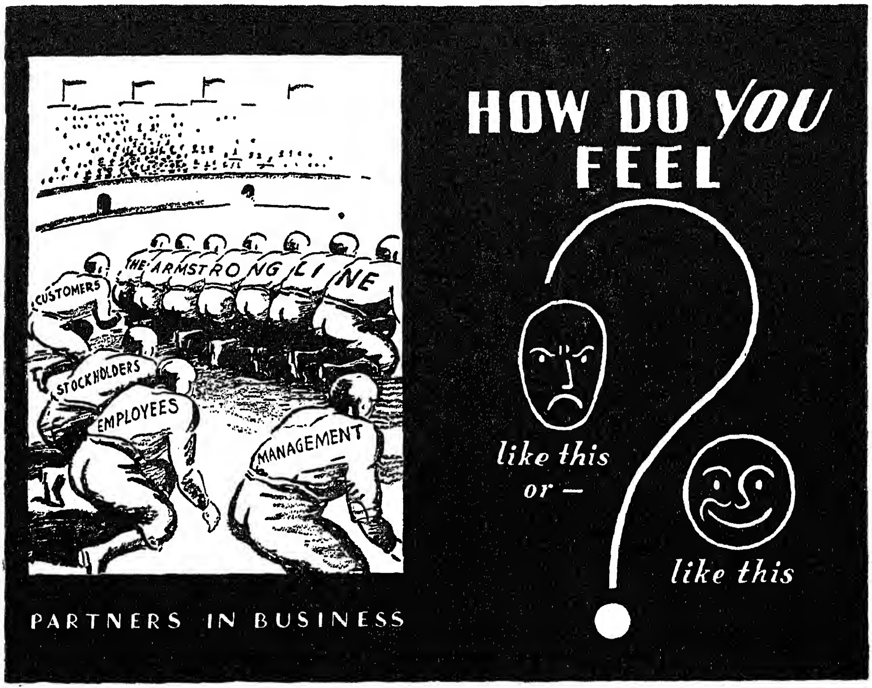
Trade agreements are negotiated through representatives of the union who may or may not be actual workers in the plant or plants which the agreement affects, and officers of the plant, or of the trade association which represents the employers affected. Disputes are ordinarily handled by departmental or plant boards on which both the union and the employer are represented. They may then be referred to a board for the industry as a whole, or a regional board, if more than one plant be involved. Finally, there may be some method of arbitration provided.

Future of trade agreements. With experience in their operation, it may be confidently expected that better administration of trade agreements will become a fact of the future. This will include a broader view by the union of the necessities of industrial management and operation, particularly in securing economies of production, and a broader view by the employer of the aims of the union. Trade agreements, however, are applicable only to trades that are highly organized and to plants within those trades where the workers would rather deal through their union representatives than directly with employers through works councils or some other form of intra-company collective bargaining. The individual plant, in most industries, which maintains the confidence of its employees, and particularly, which makes the wages and conditions of work equal to or better than the union standard, will probably continue to operate smoothly and in successful relationship with its employees without the use of trade agreements, or even without the development of any form of works council, except possibly a very loose committee organization. But such operation can be based only on a broad, intelligently developed basic personnel policy which has been formulated squarely on the idea of the development and continuance of good will between the firm, the management, and the workers.

Employees' reactions to company policies. Regardless of the program inaugurated by a company, whether it be a price policy, quality of product, merchandising medium, personnel policies, or community program, there ever remains the difficulty of determining just what the interested persons think of it. Management has long sought a method of determining just how the employees in general feel toward its policies. The works councils and other forms of employee-employer representation plans provide one means of exchanging ideas between management and men relative to many company activities. Another method of finding out what employees think about management is the use of questionnaires.

The Armstrong Cork Company of Lancaster, Pa., was one of the

pioneers in the use of the questionnaire technique to determine how its employees liked the industrial relations program. Their method merits detailed description since it is typical of other efforts along this same line. In order to determine if possible how the employees felt toward the company policies, the personnel department distributed 7,181 attractively decorated booklets, entitled "How Do You Feel?" (See Fig. 106 for the outside cover.) Each employee was requested to answer the questions



Courtesy Armstrong Cork Company.

FIG. 106. Cover of Employee Questionnaire Booklet, Armstrong Cork Company, Lancaster, Pa.

in the booklet and return it by mail unsigned. These answers were tabulated and a digest of the same was given to the employees. The following quotations from this report to the employees will give not only the questions asked but the answers received:

Dear Fellow Employee:

Replies still are coming in from the questionnaire booklet "How Do You Feel," but we do not want to wait longer to give you a partial report. You will be interested to learn that about one book was returned for every seven books given out. Even more impressive is the fact that more than 82% of the replies contained written comment. The cross section of opinion which

we wanted so much to obtain has been provided; and we want to take this opportunity to express our personal thanks to our fellow associates who took the trouble to make this experiment an outstanding success.

In an effort to make sure that our program is sound, our questionnaire was distributed to all employees. It was hoped that from the replies we would (1) discover whether or not the efforts of the Company were generally recognized and appreciated; (2) obtain all suggestions as to how they might be further improved to guide our future planning; and (3) determine how we all felt about the Company and about our own particular jobs with the Company.

* * * * *

The section headed "Shoot the Works" drew comments which ranged from "there is nothing wrong" to "there is nothing right." Enough suggestions have been provided in this section alone to keep the Personnel Department busy for some time to come.

* * * * *

The most important specific question included in the booklet, in our opinion, was "Are You Proud of the Company You Work For?" Of the 895 recorded votes, only two persons voted "No," and one of these two voted in the negative because "management in . . . department not very good."

The next question was, "Are the Policies of This Company as a Whole Progressive?" We are glad to report that 888 of the 892 who voted said "Yes." Of the four negative votes, one gave no reason for his opinion and another pointed out that he voted "No," feeling that there should be "more modern equipment to eliminate the scrap and waste"

The votes on these two questions confirm our belief that the employees of this Company have confidence in it, and that its efforts in the behalf of all those associated with it are appreciated. We are proud of this record.

The other eight specific questions asked and the vote recorded follow:

Question	Vote		Percentage of "No" Votes of Total Votes Recorded
	Yes	No	
Do you agree that the Company is doing its best to avoid lay-offs?	834	46	5.2%
Do you think the unemployment benefit plan is okay?	871	11	1.2%
Are you satisfied that Armstrong pays fair wages?	738	151	17 1%
Do you like the suggestion system?	825	31	3 6%
Do you agree with them? (Refers to statements made regarding our effort to maintain safe orderly work places)	722	50	6 5%
Is your own work place okay?	702	93	10.4%
Are you satisfied that the number of hours you work is reasonable?	868	34	3.8%
In your opinion is the vacation system for hourly workers fair?	857	11	1.2%

The total number of booklets distributed was 7181 and the number returned to October 18th was 984.

The booklets returned have provided the Personnel Department with a number of things to be studied. We accept the job with pleasure and again say—

Thanks a million,
Personnel Department.

The answers to the questions propounded by the Armstrong Cork Company speak for themselves. Just how reliable this procedure is it is difficult to say. Time and experience with these techniques will refine the methods and give the answer as to reliability.

CHAPTER XXIII

THE FOREMAN—A REPRESENTATIVE OF BOTH MEN AND MANAGEMENT

In an enterprise that employs relatively few men the dominant personality is usually the general manager. He may have various titles, such as general superintendent, superintendent, works manager, vice president, or even president. Often he is familiar with the intimate details of each department and frequently knows most of the older employees by name. To the workmen and minor executives he is the management even though he himself may be a hired employee. Such a situation exists in thousands of institutions today in America, for it should be remembered that alongside our large business enterprises there are numerically many more smaller ones. This fact is often lost sight of by students of management.

In large-scale industry the key man as far as the worker is concerned is the foreman. This fact is generally recognized, and most executive training programs are basically built upon the training of the foremen. By far most of these training programs are non-technical, but emphasize the leadership factors in a foreman's responsibilities.

The foreman's position in the organization. In a very real sense the foreman is the directing head of an important economic unit. It is true that his unit is intimately related to other departments within the enterprise, that his success is dependent upon the performance of other departments that precede his; but it is equally true that the departments that follow him cannot function effectively unless the work in his department has been properly executed. It is not unusual for a foreman in a large organization to have more men under his direct supervision than plant managers in smaller institutions. The foreman must see that materials are available for his men, that men are available for the various tasks, that work is performed according to specifications and that quality is maintained, that each worker turns out the quantity of work expected of him, that the machines are in proper working order and are operated in such a manner that they will give maximum life as well as maximum output. In other words, he is the general manager of his department. It is true that he may have staff or functional assistance in performing many of these duties, yet such aid does not

wholly relieve him of his responsibility. A wise group of functional and staff officers will consult the foreman in making many of their decisions. As a matter of fact, the foreman in practice is required to give much of his time to aiding these various staff officers. These staff officers relieve him of much of the details that he formerly had to care for, but he still remains an important person in the proper functioning of these specialized departments. By being relieved of some of the details, the foreman is enabled to exercise more effective leadership in his department. He is no longer required to be an ultra specialist in many things, but he must be an all-round leader in many functions.

The foreman's responsibilities. In the preceding chapter, many of the duties of the foreman were pointed out. An analysis of the foreman's duties will show that his responsibilities may be subdivided under three main headings: namely, to management, to the workers, and for materials and equipment, as follows:

1. *To management.*[1]
    - *a.* To transmit faithfully managerial policies to the men.
    - *b.* To transmit the worker's desires and aims to management. (This is a dual function. The foreman owes this responsibility both to the men and to the management.)
    - *c.* To get out the required production on time.
    - *d.* To maintain standards of quality.
    - *e.* To formulate plans and methods to increase productive efficiency.
    - *f.* To reduce all waste and scrap to a minimum.
    - *g.* To keep accurate records from which future action can be guided.
    - *h.* To render reports as required.

2. *To the employees under his supervision.*
    - *a.* To provide adequate instruction in
        1. Company policies and procedures.
        2. Correct methods of performing the required operations.
        3. The next job ahead to enable the workman to be eligible for promotion in case of a vacancy.
    - *b.* To maintain satisfactory working conditions—cleanliness, order, safety, and an even flow of work.
    - *c.* To maintain discipline.
    - *d.* To promote co-operative effort and good will.
    - *e.* To represent the workers to management.

[1] This tabulation is adapted from *Department Management*, Chapter 8, published by the General Motors Institute of Technology, Flint, Michigan, 1927.

f. To promote and transfer impartially when opportunity presents itself.

g. To rate the workers fairly for wage determination.

h. To encourage suggestions and to give credit where credit is due.

i. To strive to fit each worker into the job for which his capabilities are best suited

j. To recognize individual differences and to provide inspirational leadership.

3. *For materials, buildings, and equipment.*

a. To aid in the selection of most suitable material from the standpoint of use in the plant.

b. To aid in the selection of the best equipment for a given operation.

c. To handle materials efficiently so as to minimize waste.

d. To use equipment according to the best practice.

e. To inspect materials, work in process, and equipment. (This does not take the place of the functional inspection of the other departments.)

The foregoing tabulation is largely self-explanatory and illustrates the magnitude of the foreman's tasks in spite of the various staff and functional aids that have been provided.

The importance of a balanced relationship. The foreman is hired by management and, as an employee of management, is naturally expected to represent the interests of management. Since the foreman's personal success is largely determined by the performance of the employees under his supervision, he is also charged with the responsibility of looking after their interests. This dual relationship requires a very high type of discrimination on the part of the foreman in order to discharge his responsibilities equitably to both parties, yet in the final analysis he will be unfair to both parties should he unwittingly or otherwise fail to render justice to either one or the other. For instance, should the foreman, because of a special bias for management, fail to be fair in his treatment of his men, he is only piling up ill will and at times concealed grievances which will usually in the long run cost management much more in the form of strikes, restricted production, etc., than the short-run gains. Viewed from this angle, the foreman is failing in his responsibilities to management as well as to the workers. The reverse situation is also true. Should a foreman fail to give management a square deal in production output or quality because of a misguided philosophy, he is working a long-run hardship on his men, for such conditions lead to an unfavorable competitive situation for the products of the manufacturer in the market (unless a monopoly pre-

vails), which will reflect unfavorably upon the security of the workers' jobs. No man in large-scale industry exerts a more far-reaching influence upon the management-labor relationship than does the foreman. To many workers, the foreman is management, or at least the only authoritative representative of management that they know.

As a group, modern foremen are technically skilled in the mechanical processes. Many of them have served as workmen in the departments which they supervise. It might reasonably be supposed that they have the viewpoint of the worker. As far as the worker's reaction to turning out units of production is concerned, this supposition is undoubtedly true. However, when it comes to methods of supervision, foremen tend to follow the practices used by their supervisors when they were workmen.

Some practical aspects of foremanship. Sound organization requires that a foreman be clothed with authority commensurate with his responsibility. Any other situation not only tends to destroy the effectiveness of the foreman but weakens the morale of his entire department. A few men are not temperamentally suited to be invested with authority. Often such men are not emotionally stable in certain aspects of their personalities, and frequently suffer from inferiority complexes. This feeling of inadequacy may be concealed under normal relationships but become active when faced with responsibility and authority. The result is an obnoxious display of authority to cover up the real inner feelings. A man possessing ability, confidence, and a knowledge of the principles of leadership will studiously avoid all displays of authority and will use it sparingly. When a foreman has to fall back on his authority to get a thing done he may be sure that his real leadership is being questioned.

In personal contact with his men the foreman should be perfectly natural. He should avoid undue familiarity, yet not give the appearance of "stand-off-ish-ness." This is especially true of the young foreman who may have many men in his department who are older than he is. The foreman may well show a personal interest in his men but must avoid prying into their private affairs.

Under most unexpected circumstances a foreman will have his sense of fairness questioned. Every semblance of partiality should be avoided. Such items as fraternal allegiance, church membership, nationality preference, etc., may easily give rise to an unfounded charge of favoritism. It is hazardous to have only two nationality groups, or fraternal groups in a department, particularly if the foreman perchance belongs to the predominant group and the other group be large but in a minority. Should such a situation exist, the foreman should urge the employment department to make most replacements from a third group until

a better balance exists. Nepotism gives rise to charges of favoritism that no foreman can easily overcome.

The foreman's position in the organization implies that he is responsible for the conduct of his department. To be known as a real leader he must willingly assume this responsibility in stormy weather as well as when things are calm. The foreman cannot shift the responsibility to the shoulders of his subordinates, for he is also responsible for their performance and has failed in the discharge of his duties if he has not followed through to see that his department as a whole has functioned properly. The foreman who frankly assumes the responsibility for his department and gives credit to his men for successful performance places himself in an advantageous position for leadership.

In connection with the foreman's discharge of his responsibilities, a condition is arising in industry that has not as yet been satisfactorily solved. It is the tendency of labor leaders to by-pass the foreman and superintendent and to go direct to the top management with their problems. This has been complicated by top management's failure to take the foreman completely into their confidence regarding the details of these conferences with the representatives of labor. By so doing the position of the foreman has been weakened without relieving him of his responsibilities. As it stands, the situation in many instances is untenable. As a matter of principle, all decisions should be made at that executive level where sufficient information and competence exist to make them. Satisfactory relationships are encouraged where this principle is followed.

Co-operation within the department usually reflects the attitude of the head of that department. If the foreman would receive co-operation from others he must give it freely to others. The foreman who strives to aid his men in the realization of their personal objectives may reasonably expect co-operation from them. When a foreman realizes that he cannot offer merited promotion to one of his men because there is no vacancy in his department, and goes out of his way to aid this man to get promotion elsewhere in the organization, his workers will soon learn of it with a resultant rise in morale. On the other hand, should a foreman block the transfer of one of his men to a better position in another department because of his not wanting to go to the trouble of training another man, it will be difficult to keep this information from his men, with a resultant attitude of "What's the use of trying, anyway." Inter-departmental co-operation is merely an extension to other departments of the attitude existing within the department.

The foreman and the National Labor Relations Act. The foreman is considered by the National Labor Relations Board to be a representative of management as far as his actions relative to his men's member-

ship in a labor organization is concerned.[2] The only safe policy for the foreman with respect to union membership of his men is one of strictly "hands off." Even though one of his men sincerely asks his opinion about a union, under existing (1940) interpretations of the act, the foreman may be held to be guilty of an unfair labor practice, if he answers. Aside from any action of the foreman that may be interpreted as interfering with the free choice of the worker of union membership, the foreman may do anything that he formerly could do. He is, however, under the responsibility of guarding his actions so that they may not be misinterpreted months later by an inquiring representative of the National Labor Relations Board This means that the foreman should make more records of the causes for his actions than he formerly did. A failure to make accurate records with names of witnesses and causes for action may become exceedingly embarrassing later. The foreman must studiously avoid any discrimination among his men because of union membership. When he has done this and is in a position to demonstrate that he has so acted, he may continue to run his department along as sound managerial lines as formerly.

[2] See Russell L. Greenman, *The Worker, the Foreman and the Wagner Act,* pp. xiii-xvi (Harper and Bros., New York, 1939).

CHAPTER XXIV

THE ORGANIZATION AND FUNCTION OF THE EMPLOYMENT DEPARTMENT

The development of the employment department idea. Through the need for better understanding between the employer and the employee, through the increasing complexity of modern industry, and through the growth of the functional and staff ideas, the employment department in industry has developed From the standpoint of priority of development the employment function stands first among the various functions of the personnel division.

The employment department undertakes one of the most fundamental of personnel functions, securing and maintaining an adequate personnel for operations. This department had its inception in conditions which had grown up through the continued presence of large masses of floating labor in American industry. For years, with the supply and adjustment of labor left to the superintendent, foremen, and other department heads, thoroughly taken up with the performance of their line functions, there had developed a condition of hiring and firing and a cycle of coming and going, with little thought of the costs thereof. Although these conditions did not develop overnight, a realization of the desirability for their elimination did. It was not until the attention of managements, the country over, was forcibly drawn to the dollars-and-cents losses involved in high labor turnover that steps on a large scale were taken toward placing the hiring and maintaining of the working force on a sounder basis.

Plants that had centralized in a functionalized employment department the hiring and maintaining of the working force seemed to have lower turnover figures than those that had left these phases of operation in the hands of the foremen and other department heads. There quickly developed a scramble to organize employment departments and to give these departments control over many phases of personnel work which were not directly concerned with the employment function. Frequently, because of the haste in organization the right man and the right methods were not found, with the usual disastrous results of haste.

Centralization of employment work for the production forces can be justified on the following grounds:

1. Although the foreman may have much knowledge of the detailed requirements of jobs, his experience and the time that

he is able to devote to hiring men are not usually such as to make him expert in the selection of workers.

2. The foremen cannot be expected to develop outside contacts as sources of labor in a way that a centralized department can.
3. Individual foremen are not in a position to perceive the needs of the plant as a whole, and thus the centralized department is more likely to achieve that uniformity in selection which makes for a generally high character of personnel and *esprit de corps*; to place an applicant in the department for which he is best suited; better to arrange in merited cases for a transfer of workers, and better to prevent undesirable former employees from being rehired.
4. If centralization of employment of the production forces be once achieved, it is likely that the same policy will be shortly extended to all other departments of the business.

Qualifications of employment department personnel. To insure the high standards of operation which are usually expected from the creation of the employment department, the employment manager must be a man of broad vision and winning personality. He must be able to win the confidence, sympathy, and appreciation not only of the employees, but of the heads of departments. In order to build up this condition, the employment manager frequently is forced to keep his eye on long-run policies rather than on individual cases in which he may differ from the department head.

Under this policy, with the development of a well-run employment office, the cases in which selections made by the employment department will be rejected in the operating department will be very rare indeed. There is usually no necessity of sending more than one candidate to the department head, because, after a period of time, the employment manager soon learns the types of workers whom the department head simply does not like to have around.

To make for soundness of selection, it is essential that the employment manager, or his assistant, whoever interviews applicants, shall have a first-hand knowledge of the requirements of jobs. Thus, an interviewer of applicants for workers in the shop should have shop experience even though it has been acquired as a special student in preparation for his work in the employment office. No matter how complete the employment department's record of jobs, there is no substitute for this. In addition to these qualifications, it is, of course, essential that the interviewer be specially qualified in the *power of analysis*, in his *knowledge of human nature*, and that he possess a *constructive imagination*.

In selecting employees, the employment department must fill requis-

tions which are submitted to it by the operating departments. These requisitions may be developed in conference at the time that some production or expansion program is decided upon, or they may take the form of routine requisitions, which may be made out on specified forms, submitted by the departmental heads from time to time as necessity dictates. The cause of the vacancy should be indicated on the requisition. This will enable the employment department to have a written record from the production departments of the way in which they are filling jobs. The requisition should reach the employment department as far in advance of requirements as is practical.

Job descriptions. The employment department is greatly assisted in its operations if it has developed a set of job descriptions for all jobs for which it is called upon to supply workers. These descriptions are of particular value in large organizations, where it is impractical for the employment manager or the interviewer to keep in mind the conditions of work of all jobs. In smaller organizations, it is possible that they will have a knowledge of the jobs which is more complete and accurate than anything likely to be developed on paper. Much information for job descriptions can be secured from the methods department, or whoever has control of the taking of job studies. The employment manager should be entirely familiar with the job-study data which have been secured. In working up job descriptions for his purposes, however, he frequently needs some information of another kind and must also translate for his purposes much of the information on the job-study observation sheets. Job description data should not be too elaborate. There is likely to develop a tendency to gather a mass of detailed information which it is impractical to utilize.

In constructing the job description, its use should be kept constantly in mind. The job description should include only those factors which affect the worker and will aid the employment officer in selecting a worker for the particular job.[1] Particularly when business conditions are good, it is impractical to try to fit workers too closely to the job at hand. There has been far too much talk during the past few years of square holes and round holes in the organization, which are to be filled with square pegs and round pegs by the employment department, these pegs to be in the form of new employees, and the holes in the form of job descriptions. We all know that even the most routine jobs, be they in the office, in the service department, or in the manu-

[1] See J. E. Walters, *Applied Personnel Administration*, Chapter 11, John Wiley & Sons, Inc , New York, 1931; Dale Yoder, *Personnel and Labor Relations*, Chapter 5, Prentice-Hall, Inc., New York, 1938, for a complete description of this subject. The authors use the term job specification to signify a detailed analysis of a given job. Others use the terms specifications and descriptions interchangeably.

facturing end, are often transformed by the person who holds the job. Although this does not mean that every attempt should be made by the employment department to find workers who approximate the ideal for a given task, it does mean that *a new employee should be first of all an organization person,* with some chance of fitting in with the group in the department in which he will work, and *secondly, should have general qualifications fitting him to perform a type of task, rather than be theoretically a perfect specimen to fit the particular niche that is vacant.* Business is dynamic, not static, and if the employee fits the particular niche too well, we are likely to find him fitting the original niche after

1	2	3	4	5	6	7	8	9	10

JOB NAME — THE AMERICAN PULLEY CO. — JOB SPECIFICATION

DEPARTMENT — 1. GENERAL — SYMBOL

2 MINIMUM QUALIFICATIONS OF OPERATOR

☐ MALE ☐ FEMALE — ENGLISH ☐ READ ☐ WRITE ☐ SPEAK — SCHOOLING ☐ COMMON ☐ HIGH 1234 — NATIONALITY PREFERRED — FROM AGE TO — SIZE ☐ TALL ☐ SHORT ☐ HEAVY ☐ MEDIUM

TRADE EXPERIENCE NEEDED — PHYSICAL

3. NATURE AND CONDITIONS OF WORK

LOCATION	POSTURE	SPEED	ACCURACY	SIZE OF MATERIAL	AUTOMATICITY	HEALTH HAZARDS	DANGEROUS FEATURES	ACCIDENT HAZARD

MACHINES USED — PERSONAL TOOLS REQUIRED

TOOLS USED — TIME REQUIRED TO LEARN OPERATION

DEPARTMENT HEAD — EMP DEPARTMENT — DATE

FIG. 107. Front of a Simplified Form of a Job Specification Card.

it has changed shape entirely through the interplay of new forces or new ideas in the business.

Effective job descriptions aid, not only in employee selection, but in his transfer and promotion. If they are intelligently utilized by the employment department they aid in preventing the overselling of the job to the prospective employee, with the resultant high leaving rate within a few weeks after employment. They should include a consideration of minimum qualifications of the employee, rather than maximum, a full statement of the conditions under which the work is done, in order that the interviewer's memory may be refreshed when he is seeking a worker for a job, should indicate the pay, and the lines of promotion which seem to be open for the job. (See Fig. 107.)

Sources of labor supply. For convenience, the sources of the labor supply might well be classified under two general headings, from *within the organization,* and from *outside sources,* as follows:

I. Within the organization.
   1. Transfer.
   2. Promotion.
   3. Recommendations of friends and relatives by satisfied employees.
   4. Former employees who were in good standing when they left.

II. Outside sources.
   1. Direct application in person or by mail.
   2. Employment agencies.
      a. Union agencies.
      b. Government sponsored.
      c. Private.
      d. Religious and fraternal.
      e. Employers' groups.
   3. Other business exchanges.
      a. Reciprocal agreements with certain employers to supply men.
      b. Agreements as to lay-off and discharge.
   4. Contacts in other localities.
      a. Labor department reports.
      b. Newspaper advertisements.
      c. Trade associations.
   5. Educational institutions.
      a. Public schools.
      b. Trade schools, both public and private.
      c. Colleges.
      d. Training schools of manufacturers of special equipment.
   6. Advertising.
      a. Newspapers and trade journals.
      b. Radio, posters, billboards, etc.

Space will not permit a detailed discussion of all these sources. A few of them merit special consideration. Advertising as a rule is of questionable value save for persons of special skills or training. It is usually resorted to only when there is a labor shortage, and results in taking workers from another employer who reciprocates in kind with little if any social or economic advantage.

A large proportion of new workers must necessarily be selected from those who apply at the office, although this is generally the least satis-

factory source of supply, particularly in good times. Applications by mail are frequently received, and they form a satisfactory source, particularly in the case of firms with good employment reputations, who are likely to attract workers already employed. Of course, follow-up interviews are necessary before selection, regardless of the amount of correspondence. Workers already employed are likely to recommend others for consideration. These recommendations may easily prove one of the best sources of supply, since they know the plant conditions and are not likely to make recommendations unless they feel that these others will also be satisfied.

Of the contacts which can be developed between the employment department and outside organizations, those with employment agencies need the most careful study. There are some employment agencies that go about their work in every bit as professional a manner as the best-conducted company employment department. Such agencies will recommend only persons who they feel confident will fill the opening. In every large community, however, there are many agencies which come just within the letter of the state law governing their operation, and which are not good contacts for the employment department. Public employment agencies are now found in nearly all communities. These have not as yet developed into all that might reasonably be expected of them save as a source for common labor.

Care should be taken also not to place too many foreign-speaking men of the same nationality or too many persons of a particular religious faith in one department, or cliques will develop. Trade organizations are valuable aids, especially when there is some form of collective bargaining with labor in the plant. In some industries where collective bargaining has been established, particularly in the clothing industry, joint offices have been provided as an aid to the plant-employment managers. Schools, colleges, and specialty concerns who train workers in business practice, such as filing device distributors, all form valuable contacts. Frequently close relationships can be built up with technical high schools that will yield a very satisfactory source of supply in their graduates. Candidates for future executive positions are found more and more among graduates of colleges, and many such institutions have provided departments which aid the employment manager to get in touch with their students as well as with graduates who have been in the industrial world for some years.

Interviewing the applicant.[2] It is in the interview with an applicant

[2] See Gordon S. Watkins and Paul A. Dodd, *The Management of Labor Relations*, McGraw-Hill Book Co., Inc., New York, 1938, pp. 175-178; also Guy Wadsworth, Jr., "How to Pick the Men You Want," *Personnel Journal*, Vol. 15, March, 1936, p. 335, for a more detailed discussion of this subject.

that the employment department has one of the best opportunities to justify its existence. It is not only in the selection of successful candidates that this is true, but in the method of selection, in the method of rejection, which should be such as not to create any ill-will toward the firm, and learning from the candidate those points which are pertinent to a consideration of whether or not he is likely to be a permanent member of the working force. There can be no cut-and-dried method of interviewing. Each person must be treated in a different manner, and in a way which seems best to fit the case and draw him out. It is in drawing the applicant out that the success of the interviewer rests. Some of the most successful interviewers make it a practice to find out some interest of the applicant, and to speak of that until an atmosphere of confidence and ease has been established, before the conversation is turned to openings or direct qualifications.

Application blanks have frequently been looked upon as the most important feature of the process of selection, and many of these have been designed from the standpoint of asking of the applicant every possible question that could be devised. This is wrong. Application blanks should be made as simple as possible, the questions asked should all have a bearing on the applicant's fitness for a particular job, or right to membership in the organization. Personal questions, which may aid the interviewer in determining the desirability of the applicant, should, however, be asked in the interview rather than on the blank. Furthermore, the application blank should be handed to the applicant in a way that will secure his co-operation in filling it out, rather than to have the effect of making him look at it as a piece of useless mechanism which must be filled in before the real business of the day can start.[3] If the interviewer is really to learn pertinent facts about the applicant, the latter must be made to feel more or less at home. He is not likely to feel at ease in walking into a new plant, unless he be the undesirable type of applicant, namely the "floater." The application blank may readily be used by the interviewer as a means of beginning the conversation with the applicant in an attempt to find out what kind of person he really is. It does form a valuable record of prospects in cases of applications of eligible workers for whom there are no immediate openings. When the application blank is used as a file for

[3] Some employers have the applicant fill out an abbreviated preliminary application blank only until he has been interviewed by the employment office. This saves much time and annoyance to many applicants. If the employee is to be hired, either he or an employment representative fills out a detailed application blank which is made a matter of permanent record. In case the applicant is not employed immediately but appears to be a desirable man for further call, he may be requested to fill out the more complete card.

future prospects it is necessary to recheck this file at stated intervals to keep it alive. One method is to send out postal cards at the end of the given period asking the applicant to notify the employer if he still wishes to be considered for a position. Should there be no reply or a negative reply, the application blank is destroyed.

In all employment work, the major task of the management is to make the employee or prospective employee act in a wholly natural manner, and "open up" in conversation. Since this is true, it is desirable that all features of the employment office shall be constructed with this idea primarily in mind. It is therefore desirable that where the majority of persons being employed are women, the interviewer should be a woman, and where the majority of applicants are men, the interviewer should be a man, inasmuch as workers seem to express themselves more freely to members of their own sex. This holds true also for the higher positions in the personnel organization. Courtesy on the part of members of the employment staff is a fundamental necessity, if the plant is to be regarded in the community as a "good place to work."

The setting for the interview should be in keeping with the over-all plant environment. It should be clean and comfortable but avoid ostentation and display. An employment office for a bank or a department store might well be more elaborately furnished than that of an industrial plant.

It is the task of the interviewer to sell the plant to the applicant, and to sell it to him fully, but it is likewise his task not to oversell either the plant or the job. The basis of many other personnel activities is to be found in the impressions gained by the worker in his first few days in the plant. If the interviewer is successful in his relations with the workers whom he is interviewing, he can develop an attitude toward the plant which will go far toward making the worker feel at home during the first trying days. No matter how badly a worker is needed, it is distinctly bad policy to oversell the job. This may be done by exaggerating its good points, or by consciously or unconsciously not mentioning all its bad points. The bad points will be discovered quickly by the worker. If he be not prepared for them, there is the likelihood that they will appear even worse to him than they actually are.

Employment tests. One of the mooted questions of personnel work is the matter of employment tests. Much has been written and many experiments have been made with these tests, both trade tests and mental tests, including general intelligence tests and rating scales. Their place in industry is still a matter of controversy, but it may definitely be said that they cannot be relied upon too extensively, unless they have been designed and checked especially for the particular job. *Tests are frequently of more value in determining a minimum below which*

the applicant has little or no chance for reasonable success than for rating the relative merits of those applicants whose scores are high. Trade tests, which presume to test directly the abilities of the applicant for the job by having him do some work along the lines in which he is supposed to be skilled, unquestionably eliminate the "bluffer." But frequently it is necessary that a worker be given a chance to produce over a long period, because of the peculiar type of work or arrangement of machinery in the plant, or because of the scarcity of skilled workers at the time. The statement above regarding minimum scores is also applicable to performance tests. A large food distributor devised a simple test taken from actual computations required of route salesmen. They found that those who made four or more errors within the allotted time were almost certain to have difficulty with record-keeping and making change. On the other hand a perfect score did not insure a successful route salesman or well-kept records. The test eliminated the ones who could not perform but it did not insure that the others would perform. Performance tests are valuable for simple kinds of work, such as typing.

Trade tests, which consist of showing the applicant a picture of a machine and then asking him a series of questions concerning it, or asking him for other similar trade information, are somewhat more valuable, provided the test is used as a part of the general interview, and not given like a Civil Service examination. Although the poorest worker may readily pass the best examination in case his mind happens to run in such channels, nevertheless, if properly devised, such tests may gauge the actual ability of the applicant with considerable exactness.

Mental tests, such as general intelligence tests, are of less proved value in the selection of workers, except for setting minimum standards, thus eliminating certain applicants. Even here care must be exercised. An individual who could not learn certain skills under competitive conditions within the required time limits imposed by industry may have acquired these skills under less exacting conditions and be an average worker. He might fail the general intelligence test and yet pass the performance test. Intelligence tests may give some idea of mental quickness or general knowledge, but they have not been developed to give a convincing test of fitness for specific jobs. Mental tests which are so designed as to check some particular ability may be regarded as somewhat more successful. Thus a test which will indicate quickness of perception may be utilized as a partial guide in hiring persons to do assembly work on small parts. Rating scales, which may be of some value in the promotion of executives, provided the rating be intelligently done, must be used with great care in the selection of applicants for any

position. All methods of character analysis by means of physiognomy have been proved useless, and most advocates of these methods found to be fakers in the highest degree. Any test based on this idea is in reality only making the applicant for employment subject to the fundamental or acquired prejudices of the interviewer.

The statements above regarding the use of employment tests should not be interpreted to mean that they should be thrown out entirely. As a matter of fact, they ought to be used much more generally than is now the practice, but they should be used with discretion and as aids, not final determinants in themselves.

Physical examinations. In plants having physical examinations of applicants, with a doctor always in attendance, this examination may readily be given before the worker is employed. It is wasteful to spend all the time necessary to write up all employment records unless the applicant can meet the physical requirements. In plants where the doctor pays only periodic visits, the examination may come after the worker has been provisionally at work for a day or two. This depends mainly on the purpose of the examination. It is largely used today, not as a means of complete rejection, except in cases of communicable diseases, heart or respiratory disorders, and a few physical handicaps, but as an aid to intelligent placement and follow-up. Unless there are physical examinations, it is very likely that workers will be assigned to jobs which are beyond their strength, or to which they are peculiarly unadapted from the physical standpoint, when they might as well have been assigned to jobs which they could satisfactorily perform. Many workers and some workers' organizations have objected to physical examinations because they have felt them to be predicated on the idea of rejecting the employee if he were not 100 per cent perfect physically. Of course, there is usually no such idea, but nevertheless there is a certain fundamental reaction which springs up in large numbers of men against taking a physical examination before they are given a job. This is a fact which must be recognized and guarded against. This attitude on the part of workers is much less prevalent today than formerly. Many organizations have been using complete physical examinations for twenty years or more and seldom encounter any complaint. On the other hand, there are some communities where physical examinations are relatively unknown.

Introducing the worker to the job. The function of employment does not end with acceptance of the worker by the employment department, and with his acceptance of the job. One of the best ways of having a new worker become dissatisfied with plant conditions is to have him misunderstand them. If the new worker is started to work without any adequate explanation of the aims and policies of the con-

cern, and if his job is detailed and repetitive, day in and day out, is it surprising that he will not readily listen to tales of the "real aims of the plant"? It is desirable that he be given a bird's-eye view of the plant, its history, policies, and aims, and be shown his connection with it all. One of the most common ways of attempting this is through a booklet which is handed to the employee at the time he begins work, and which may have any title except "Regulations."[4] Some concerns place the name of the employee on the cover of the book. As previously stated, a personal introduction of the worker to the man under whom he is going to work is a necessity. Either the foreman or the employment-department representative should be careful to introduce the new employee to those around him, and to show him the facilities for his personal comfort, such as locker and wash rooms, as well as those phases of plant routine which intimately concern him, such as entrances, clocks, methods of securing pay, and various service features.

Not only should the worker be properly introduced to his job, but he should be carefully followed up, especially during the period immediately after he is employed. That is the period of most difficult adjustment, and the time during which the heaviest turnover figures are run up. In some plants, representatives of the employment department, sometimes even the interviewers themselves, go to the various departments and talk with those who have been recently hired, in an attempt, not only to secure the reactions of the worker to his job, but to check up on the judgment of the employment department, so that transfers may be made if necessary and advisable, at the time when they will do the most real good.

The "sponsor" system is used by some employers. Certain reliable employees in each department who have demonstrated their interest in their fellow workers are designated to aid the new employee in getting adjusted to his new environment. The sponsor accompanies the new worker to the lunch room, shows him the locker room, explains the many rules and customs that have grown up in the department, and in general conveys to the newcomer that there is at least one member of the group on whom he may call for guidance and upon whom he may look as a friend. The sponsor may be paid a nominal sum for this service or he may be granted certain special privileges, such as additional days of vacation with pay, not having to punch a card as he leaves and enters the plant, special parking privileges, etc.

Transfers and promotions. Inasmuch as the employment department is charged with providing a satisfactory working personnel for the organization, it follows that control of transfers from department to department or of promotions must rest largely with it. The matter of

[4] See Chapter XX, "Methods of Interpreting Personnel Policies to Employees."

transfers is often a ticklish problem, particularly if the reason for transfer is the fact that the employee did not get along with the head of his department. The latter may readily rise to a point of personal privilege and demand that the worker leave not only his department, but the organization as a whole. This will frequently be difficult to deny and almost as frequently unwise to deny. But there are times, even in disciplinary cases, where it is desirable to transfer workers from one department to another. If the general impression is created that workers are in the employ of the concern at large rather than in any particular department, this practice is made easier. This practice of restricting the right of discharge by the foreman to his department only is becoming increasingly prevalent. Even in plants where it is not a definitely recorded policy it is receiving tacit approval which is often as effective as an ironclad regulation.

A promotion system, which frequently involves transfers, is a most valuable adjunct to any personnel policy, where it can be worked out. Lines of promotion should be clearly defined wherever possible, and every effort made to create real lines of promotion. Frequently simple promotion schemes are effective, such as transferring a worker from dirty or greasy work to clean work, or from a night shift to a day shift. One of the reasons why a well-developed system of promotions and transfers is necessary, is that if some such scheme is not worked out, there will be a tendency for the department head to keep his best workers in the jobs that they hold. He may seek immediate low cost rather than ultimate low cost. If morale is important to ultimate low cost, as it unquestionably is, promotions are necessary, for there is nothing that builds up morale as does a real promotion plan. *This does not mean that personnel should never be brought in from the outside for executive or subexecutive positions.* On the contrary, *if an organization fills all executive vacancies from the ranks, it will lack the drive that comes from new ideas, and any promotion policy must be tempered with this knowledge.*

Another factor in promoting from within is the tendency to adjust the working force to absorb at the lower levels the work of the promoted employee. It is a well-recognized fact that somewhat more than the required number of men are usually carried in large departments, particularly on the lower levels among day workers or even group workers. In such situations the promoted employee is seldom replaced. The same production is usually turned out with the same number of men which results in an increased efficiency per man.

A promotion scheme, including a line-of-promotion chart, cannot always be drawn up and posted, particularly in small organizations. Nevertheless, the employment department can be always working toward

such a scheme; and in large organizations, where there are the most blind-alley jobs, the development of the idea is easiest. The aim is to make sure that the worker has the maximum of responsibility and earnings, and the firm has the benefit of his greatest ability. In working out such a program, quantity and quality of work, length of service, attendance record, number of dependents, age, and physical and mental fitness must all be taken into account.

Discharge, quits, layoffs, records. Policies differ concerning the extent of control of the personnel division over discharge of employees. In most plants which have developed employment departments, the employee must at least pass out of the plant through the employment office, in order that a record may be obtained of the reason for severing the connection.

The policy in many organizations is that the department head may discharge an employee only from his department. In principle this program is sound and when carried out in good faith by all parties concerned few if any serious disciplinary situations arise. The personnel representative, usually the chief employment officer, handling such cases must use real human engineering principles to get maximum results. The foreman is jealous of his reputation; so is the workman. Both parties are anxious for a chance to "save their faces." Each man desires not to lose status in the eyes of his associates. When possible it is best to transfer the worker to a division of the plant as far removed from his original job as is practical. Each party usually feels better about the matter when the employment officer can tell the worker that his former foreman recognizes that the worker would possibly make good in another department and has recommended that he be given a transfer if possible. A skillful employment adjuster frequently secures the co-operation of the foremen to the extent that he will call the employment office before discharging the worker.

In the event of a discharge special care should be exercised to make a matter of record the cause of the discharge. This may well be signed by the foreman, the superintendent, and the employment officer with any other witnesses who are available. Such a record may be invaluable later in a hearing before the National Labor Relations Board in case a claim is made against the company to the effect that discrimination was made because of union activities. In some states unemployment compensation does not become payable as quickly when an employee is discharged from one department and refuses to accept a transfer to another department. Unemployment compensation now makes it highly desirable to have accurate records of employees' quitting of their own accord. Records showing the cause of employees' leaving have recently acquired special significance in view of social security and other legislation.

Many times men are laid off from the working-force of a department because of a reduction of work in the particular department, who can readily be used in other departments of the concern. In such cases, an orderly procedure, rather than a mere dismissal of the employee, will frequently result in the retention of many employees who can be used in other positions.

Labor turnover. A statistical analysis of the number of workers employed in each department, the number hired over a period, and the number of exits, carefully classified, is a measuring-stick of the effectiveness of the labor policy of a plant, and of the effectiveness of operation of the employment department. The number of exits should be carefully subdivided as to voluntary withdrawals, those laid off, and those discharged. It is in the subdivisions of these main causes of exits that the most valuable data will be secured for the development of the personnel policy. Whether the voluntary withdrawal is because of dislike for the work, "better job," which frequently should be interpreted higher pay, conditions at home, or other reasons should be fully investigated before the employee is allowed to leave. At times the real reason cannot be ascertained; but at other times, if as much care is given to the interview when quitting as is given to the interview at selection, some real information will be secured for policy-determination. The first cause given by the worker cannot always be accepted as the real one. In addition to a compilation of causes of turnover, the employment department can prepare other interesting and valuable bits of statistical compilation, such as an analysis of the working force according to earnings, length of service, or nationality. These analyses can also be combined with turnover statistics by departments as an aid in policy formulation and better selection.

The term, *labor turnover,* has acquired special statistical significance. It has had different interpretations at different times and by different groups. The *net labor turnover* is the most commonly used term at present. It may be defined as the number of replacements per one hundred workers in the average working force. There are several other definitions but the one given is in quite general use. The formula for computation is

$$\text{Net labor turnover} = \frac{\text{Total replacements}}{\text{Average working force}} \times 100, \text{ or}$$

$$T = \frac{100R}{W}$$

The Bureau of Labor Statistics of the Department of Labor collects these data and publishes a monthly index for the entire United States broken down into major manufacturing industries. The figure may be

expressed for the month or on an annual basis. Unless otherwise specified, the annual rate is used. This is by far the most reliable index available on a large scale. It is, however, subject to certain limitations. It is a crude unadjusted index and does not take into account seasonality. Again, it does not distinguish between the causes for labor turnover. Replacements of all types, regardless of cause, are lumped together. The cause of replacements is of major significance for remedial personnel control. This fact has led many employers to keep a special refined turnover rate for their own guidance. In this case their refined net turnover rate would be the ratio of the avoidable separations to the average working force (per hundred). This formula would be $T = \frac{(S - A)\ 100}{W}$. A stands for unavoidable separations, S for total separations, and W for the average working force for the period.

CHAPTER XXV

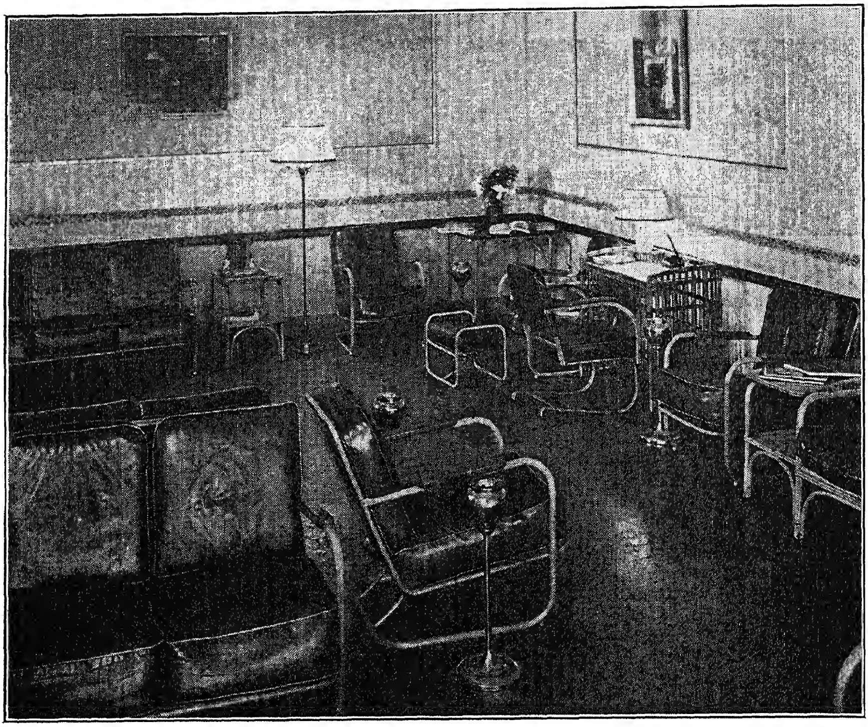
EMPLOYEE SERVICE ACTIVITIES

One of the most unpopular phrases in the industrial vocabulary is "welfare work." The idea that this constituted doing something for the working man which would better his "condition," coupled with the plant-advertising features which frequently accompanied it, has eliminated welfare work from modern industrial management. In its place has been substituted "service work." Not that there is anything in a name, but there is much in the different attitudes which these two phrases express. *Service work includes all those activities which are not directly concerned with production, but which make the plant personnel a healthier, sounder-thinking, more forward-looking group.* To avoid the pitfalls that caused the idea of welfare work to fall into disrepute, the plant must studiously avoid any semblance of the attitude of saying, "See what we are doing for you." The only excuse for a management's including service work in the industrial program is that it will make the employees a group of citizens who will be better able to carry on the productive processes, or that it constitutes a development which has been approved by the express will of the employees. A safe principle for guiding the inauguration of service activities is to have them grow out of the work situation, and in most instances to be the result of employee request. In all instances a more favorable attitude will result if the employees participate in the determination of the general nature of the activities.

Locker rooms and rest rooms. There are certain features, generally classified under service work, the desirability of which cannot be questioned, either from the standpoint of the employer or of the employee. They are in reality a portion of any sound policy of operation and may be placed under the personnel division merely for convenience of administration. Such activities are the operation of adequate locker rooms and wash rooms. In many organizations the locker rooms, etc., are under the direct supervision of the department head and are kept clean by the janitor force the same as the rest of the department. Regardless of the organizational set up, the personnel department will be interested in their adequacy just as it is in plant safety and sanitation.

Locker rooms should provide individual lockers and wash rooms should be constantly supervised and kept clean. Rest rooms for women (Fig. 108) come under this heading, and are uniformly desirable, if not maintained on too elaborate a scale.

Health service by the medical department. The functions of the plant doctor have come to include more than a physical examination of applicants. Many organizations in which there are no physical examinations for employment have a plant doctor, either on a full-time or a part-



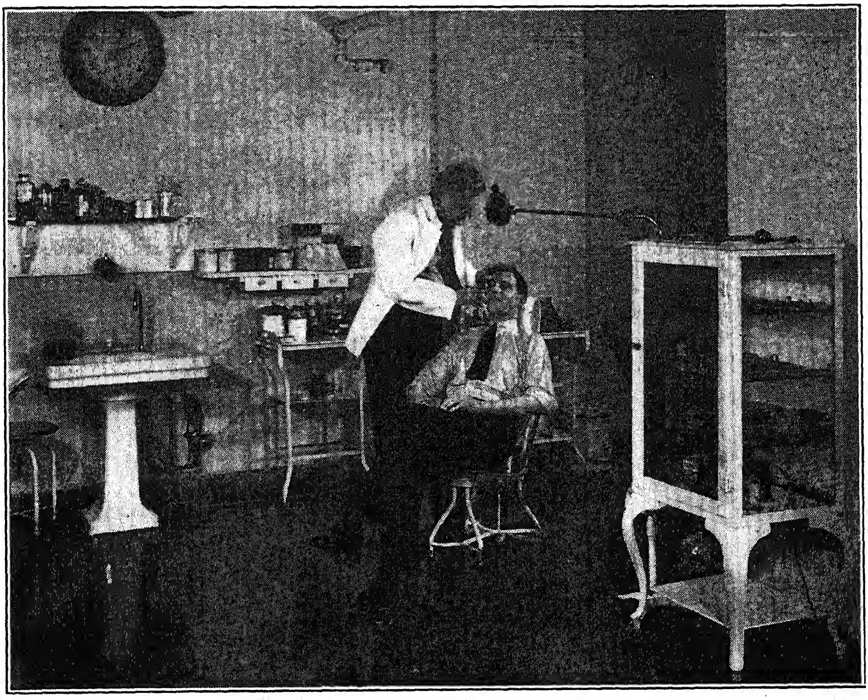
Courtesy Montgomery Ward & Company.

Fig. 108. A Corner of the Ladies' Rest Room and Recreation Room of Montgomery Ward & Company, Chicago. (While many rest rooms are not so elaborately equipped, this rest room illustrates what may be done for employees.)

time basis. The proportion of time that he is at the plant usually depends somewhat on its size. The doctor usually maintains a dispensary with a nurse in attendance, not only for accident, but for health (Fig. 109). If the plant be fairly large and the doctor on a part-time basis, the dispensary is usually in charge of the nurse, who, when occasion demands, will also go out to the homes of workers who are ill and who desire her aid. This home visiting may take the form of a systematic

follow-up of all workers who do not report for duty on a given day. When thus organized, it has the added purpose of decreasing absenteeism. Such home visiting must be carefully handled if the attitude of paternalism is to be avoided.

The greatest function of the medical department, if organized to give health service, is to keep the worker well and on the job. If the confidence of the workers can be secured so that they will report to the dispensary when they first feel ill, a large share of absenteeism will



Courtesy Tire Department, United States Rubber Co.

FIG. 109. Industrial First Aid Room in Charge of a Practicing Physician.

usually be eliminated, and the spread of an epidemic within the plant may possibly be checked.

Communicable diseases demand practically daily watchfulness, with foremen instructed to be observant. Likewise, health officials must be quickly informed of epidemic or multiple illness of all types. Provision should be made for treatment of trivial illnesses, first-aid, dental prophylaxis, and ocular attention of a prophylactic and emergency nature, as well as the usual surgical treatment of minor injuries. Except in isolated communities, as a rule, major surgery and sickness should go to

outside hospitals or elsewhere. Finally, compensation approvals must pass under the physician's scrutiny.

Industrial physicians should be allowed to lay stress on health complaints made by workers and not wait for sickness disability. Surgery, in the face of disability statistics, certainly requires much less stress than ordinary sickness. Real occupational diseases constitute a very small part of the sickness disability occurring among workers. It has been found that sickness causes twenty times as many cases of absenteeism as accidents and is responsible for seven times as much loss of time from work. True, the greater portion of sickness disability among workers is extra-industrial in nature and is equally prevalent among adults of like ages and sexes in the community, perhaps more so; but a considerable part can be greatly influenced by industrial environment and methods of personnel supervision and, as such, is capable of considerable reduction in the matter of days of absence from work.[1]

A medical department can do much to reduce compensation claims and loss of production time, but only if it is skillfully directed. Industrial physicians and nurses must understand the human side of their daily contacts. They must at least be given a cheerful place in which to work, and one that is central enough to make it convenient to all the workers. It has been found impractical for most plants employing less than 500 workers to employ a physician on full time. Plants employing from 500 to 2000 workers may or may not employ a full-time physician, while plants with over 2000 workers almost uniformly do. These facts, together with the cost of medical department operation, have been worked out in a very complete study by the National Industrial Conference Board.[2] This study indicates that the annual cost per worker of well-organized medical departments will average about $4 50, the cost for the smaller plants being higher, or in the neighborhood of $6. The General Motors Corporation, in their Annual Report for 1938, stated, "During 1938 the corporation spent $960,297 in the United States to protect the health of its factory workers on their jobs. This expenditure, which amounted to $7.63 for each of the 125,836 hourly workers, was for medical service, hospitalization, physical examinations and for miscellaneous activities to safeguard employees from occupational diseases. In 1937 the expenditure was $1,262,635, or $6.50 for each of the 194,398 hourly workers." These figures cannot be viewed properly without considering the reduction in compensation claims and lost

[1] Adapted from address by Emery R. Hayhurst, M D., Ohio State University and State Department of Health, Columbus, before Conference on Women in Industry, Special Bulletin No. 10, Pennsylvania Department of Labor and Industry.

[2] National Industrial Conference Board, *Research Report No. 37*, pp. 10-11.

time and the increase in general contentment, due to the good health that such departments bring.

The well-organized medical department will be able to collect a mass of highly useful data for the personnel and production executives concerning unhealthful conditions and unsafe operations within the factory. The checking of causes of absence may be done by a factory nurse. The only possible excuse for entering a workman's home when he does not report for work is on the basis of being helpful if he is sick. If it be found upon calling that the worker's absence is due to any other cause there is but one procedure, namely, to withdraw promptly. Any other action is paternalistic to an impossible degree. Nevertheless, a clever factory nurse can secure much useful information in making her rounds, and her value in reducing absences is not confined to aiding ill workers to return to work more promptly. Her visits have a moral value, too, inasmuch as they indicate more strongly than any amount of regulation by the management, the importance of being on the job. No plant can long afford to carry workers who are consistently absent without cause, and the factory nurse is the proper person to find out the cause. The visiting nurse and doctor will serve as the basis for administration of sick funds maintained by any mutual benefit association in the plant. She should also be closely in touch with any charitable organizations in the community which might be interested in aiding workers whose illness has left them temporarily in bad financial situations. Some companies feel strongly that it is very desirable that the handling of such cases be called to the attention of such duly organized agencies, and left with them.

Restaurants and cafeterias. The maintenance of plant restaurants and cafeterias has become almost universal. Even when the neighborhood is blessed with fairly good places to eat, it has come to be regarded as desirable to institute a plant cafeteria. This makes possible not only the development of *esprit de corps* through the meeting of fellow-workers, but insures that workers will toil through the afternoon hours properly nourished. It is these features that make the restaurant a dividend-paying investment. Since profit is forgotten, costs in factory restaurants are usually a fraction of costs in ordinary restaurants. This is true particularly because costs are usually based on cost of food and service, overhead being eliminated. With the poorer portions of the working force, and with women workers who are also housewives, the factory restaurant makes for an opportunity to get at least one good meal a day.

Where it seems desirable, the restaurant may be given to a restaurant company or an individual on contract, provided careful supervision is maintained over its operation. Wherever possible, it is desirable that it be operated by the plant itself. The establishment of a plant restaurant

makes possible the enforcement of regulations against eating in the workrooms. In some industries, such as clothing factories, food preparation industries, drug and chemical industries, it is necessary to prohibit eating in the regular workrooms. It is desirable to have a clean lunch room in most industries. The cafeteria style of restaurants finds most favor because of the lower cost and the speed of its operation. (See Fig. 110.)

The actual management of the restaurant provides an excellent means of promoting industrial democracy. It has been found successful in some instances to have it operated by an employees' club or other employees' organizations. In one large midwest organization the restau-

Courtesy General Motors Corporation.

Fig. 110. Cafeteria, Fisher Body Plant, Pontiac Division, General Motors Corporation, Pontiac, Mich.

rant and employees' club is run by the purchasing department but is under the supervision of a committee representing the employees.

The restaurant may readily be made the center of the service activities of the firm. If entertainment features are desired, these can be provided in the restaurant, either during the noon hour or at other times. It can be made the center of employees' or departmental functions, and provides an assembly room upon which there is little desire or likelihood of encroaching.

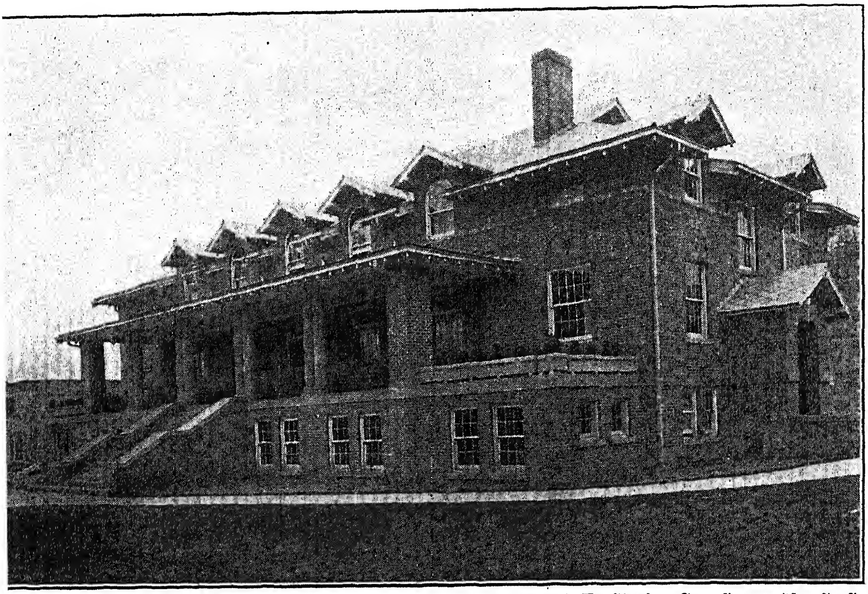
Recreational and athletic activities. In the attention paid to recreational and athletic activities lie some of the dangerous spots of service work. Recreational features may take the form of dancing, music, or speeches during the noon hour; plays, band concerts, or dances given by

workers at intervals throughout the year; or the development of clubs and club houses. These features, particularly the last, are bound to fail unless the basic wage of the plant is right. The workers will quickly see that they are costing the firm a considerable outlay, and will be likely to demand that it be put into their pay envelopes, unless they are already fairly well satisfied with their wages. If professional talent be available, it may be called upon infrequently for short concerts during the noon hour with satisfactory results. Plays and dances are valuable if they are fostered by the employees, through organizations of their own, which call upon the service department only for guidance. They are particularly workable in small towns; however, the employees of Western Electric Company, Hawthorne Station, Chicago, have had remarkable success with such activities. Clubs, particularly country clubs, laid out on a large scale, cannot possibly be successful unless the management has the complete good-will of its employees. There is too much opportunity for the criticism of large expenditures. If the *esprit de corps* has not been worked up to a high pitch before the opening of the club, it will be difficult to get the whole-hearted co-operation of all elements within the working force for its support. To avoid the charge of paternalism, clubs, after formation, should be operated as employees' organizations, and since they involve large investments on the part of the company, it is necessary that steps be taken when they are organized to prevent internal politics in these organizations from wrecking the project. If a plant be properly situated, and if all fundamental conditions be right, there is no feature of service work that will do more to cement the mutual understanding of all elements within the plant than will a club. (See Fig. 111.) If this is to be true, however, it is essential that all employees, whatever their plant status, be given an equal status within the walls of the club.

Athletics, while valuable, have been carried to an extreme in many organizations. Inter-departmental competitions tend to raise the spirit of the departments, and girls' or men's basketball teams, and men's baseball teams are particularly successful. Athletics develop health and encourage that most valuable asset to any industrial concern, team-play. They develop plant consciousness and leaders. If plant teams are formed, the tendency toward professionalism and the hiring of workers merely for their athletic ability must be guarded against. Even teams composed of bona-fide employees tend to take the primary interest of the members during the playing season, and winning from other plants becomes so important that the routine work of the week is frequently relegated to the background. In small towns, where the company team is in reality the town team, these objections are frequently wholly outweighed by the good-will which the team will build up in the community.

But too much time, too much attention, and too much money can readily be bestowed on athletic work that emphasizes competitive rather than health features.

Employees' group funds. Particularly in large organizations, funds which are built up through associations of employees are valuable from the standpoint of the employee and the plant. Such funds are those of the building and loan associations, benefit associations, and savings funds. Company group insurance plans and retirement plans are also very successful. Many companies have not been especially successful in operating



Courtesy J. E. Sirrine Co., Greenville, S. C.

'IG. 111. Many South ˜n plants have found it desirable to build Y. M. C. A. buildings uch as that illustrated. This building, at the Champion Fiber Company, Canton, J. C., is exclusively for employees of this company, manufacturers of wood-pulp. In ; are all recreational facilities ordinarily found in like buildings in medium-sized towns.

mployees' savings funds themselves, but these same companies might rell have urged the establishment of Christmas savings clubs, vacation unds, or building associations, and can lend the time and experience of ne or more of their executives or lawyers to act as an advisor to such roups. The board of directors of such associations, to be successful, must e composed almost entirely of workers, with probably one representative f the management, who will sit for the purposes named. Associations f employees created for savings purposes of one kind and another form ne of the most excellent foundations for the beginnings of co-operative

management. Savings funds usually work out best if they have some particular purpose in view, such as is found in Christmas savings clubs.

Credit unions or workers' banks have been signally successful as a medium for saving on the part of those workers who have a surplus and a source of funds at reasonable rates for those workers in need of immediate funds. They may be organized either under state or national laws. The workers themselves *control* them. Management may underwrite them to the extent of providing free office space and clerical aid in some instances such as making payroll deductions for repayments, bookkeeping, etc.[3] The credit union of one Chicago firm has deposits exceeding $1,000,000. Dividends are usually limited to 6 per cent, with excess earnings going to surplus.

Group insurance. Group-insurance plans were formerly utilized largely by companies as means of putting a premium on length of service. They were sometimes used together with increased wages for length of service, but frequently formed the only length of service bonus. The provision for group insurance has increased greatly in recent years. Length of service is still a vital factor in some group insurance programs. Nearly all of them require a waiting period such as three or six months before the worker is eligible. Many of the programs today are based not on the length of service but on the earnings of the employees; for instance, employees earning $4000 and above may be eligible for $5000 insurance; those earning $3000, $2000, $1500, and $1000 or above may respectively be eligible for $4000, $2500, $2000, and $1500 in group insurance. Where length of service is the determining factor it is not unusual for the company to bear all the expense, and the insured amount is usually lower. This practice, however, is by no means universal. The advantages to the employees are lower rates and no physical examination because the policies are taken out on the group basis. One disadvantage of group insurance where the worker pays most or all of the cost, from the standpoint of the younger worker, is the fact that his rate is often higher than he would be required to pay should he buy the same protection alone. This fact has encouraged company contributions, which is the prevailing system.

Retirement plans. Retirement plans are usually worked out on a scale which varies with length of service. The plan of the Colorado Fuel and Iron Company, which is typical of the best-developed retirement plans, provided for the retirement of all employees of sixty-five (women, fifty-five) after twenty years of service, or the retirement of employees

[3] See R. F. Bergengren, *The Credit Union: a Cooperative Banking Bank,* Credit Union National Extension Bureau, Boston, 1931; also Annual Reports of Farm Credit Administration, a bureau which administers the Federal Credit Union Section.

of sixty (women, fifty) after thirty years of service, with certain special provisions for others. The retirement payments are 30 per cent of the average pay per month of service during the ten years next preceding retirement, with a minimum of $20 per month. The plan is in charge of a Service Retirement Board consisting of five officials of the company, who have discretionary power to retire others than those affected by the major provisions, as for instance, employees who become physically incapacitated for service.

It is highly probable that individual company retirement plans may in the long run be greatly modified because of the Social Security Act which makes mandatory a contribution by employers, based on their payrolls, toward old age annuities for their employees.[4] Companies whose competitive position will permit them to do so may reasonably be expected to continue to try to work out some retirement programs on a contributory basis for their employees.

Co-operative stores. Companies that manufacture articles of wearing apparel, or other articles which employees are interested in purchasing, usually maintain retail counters or stores at which employees may purchase the product at wholesale. Other companies maintain retail stores for the purpose of selling groceries and other necessities. These are best operated on a co-operative basis, if criticism and ultimate failure are to be avoided. Occasionally these stores will sell coal and other expensive necessities on the weekly basis. Articles are usually priced on a basis of cost plus handling charge, with inventories taken frequently and prices adjusted accordingly. Sometimes there will be an attempt to make a profit, with this profit turned over to the mutual benefit association of the plant. Some company stores remain open all day, when either workers or their families are permitted to make purchases. Other stores are open only just before and after working hours and at the noon period. A large store may utilize a box into which orders can be dropped. These orders are filled during the day and are ready for the worker when he calls for them in the evening.

Company stores were more prevalent just following the World War when retail prices were soaring. Opposition from local merchants is very common, especially when the company store does not limit its activities to the company's own products but does a general business. The Ford Motor Company a few years ago operated a gigantic store for its employees in the Highland Park Plant. Local merchants complained bitterly. Eventually the store was closed.

[4] See Dale Yoder, *Personnel and Labor Relations,* Prentice-Hall, Inc., New York, 1938, pp. 541-549.

CHAPTER XXVI

EMPLOYEE TRAINING METHODS

Educational Programs

There are two major divisions into which the industrial educational and training programs may logically fall, namely, (1) the specific training for job or occupational tasks and (2) the general educational program which has as its objective the raising of the over-all intellectual

Courtesy American Rolling Mill Co.

Fig. 112. Instruction in Company Policies for New Employees, American Rolling Mill Co., Middletown, Ohio.

level of the group, the transmitting of company policies to employees (Fig. 112), training in health and safety practices, promotion of good citizenship, and morale development. Practically all business enterprises engage in both these types of activities in a limited way even though no formal programs exist. Only the larger organizations can spend the necessary money to have an organized effort in all these fields.

Much of the strictly educational work can frequently best be carried out by the formation of clubs among the employees, which will be able to carry on the educational work with but little guidance from the personnel department. If a plant library is to be established, which is sometimes particularly desirable in small towns, it can best be put under the supervision of some employees' club or association, although it should not be necessary that any employee be a member of that organization in order to secure the benefits of the library. Educational work along the lines of thrift and sound financial advice is frequently possible, but can probably best be carried on through the plant paper. In case there are savings funds or other similar plant organizations, thrift education can best be handled by these.

A few of the larger corporations such as the Goodyear Tire and Rubber Company, the Ford Motor Company, the Chrysler Corporation, and the General Motors Corporation have at times conducted elaborate educational programs. The Chrysler Corporation has the Chrysler Institute of Technology; the Ford Motor Company has the Edison Institute of Technology; and General Motors has its General Motors Institute of Technology at Flint, Michigan. It is true that these schools have as one of their objectives the training of executives and as such might reasonably be classed under the specific heading of training for executives. On the other hand, many courses are offered in the school at Flint which are of a general educational nature. It is doubtful whether or not such programs will increase in number, especially when viewed in the light of changing educational trends in the regularly organized colleges such as the co-operative courses at the University of Cincinnati, Antioch College, Massachusetts Institute of Technology, and the Technological Institute of Northwestern University. The evening classes for strictly educational purposes have grown rapidly in recent years.

The plant publication. One of the most successful ways of developing and maintaining the right basic personnel policy is through the plant publication. Such an organ will thoroughly acquaint the employees with each other and with the management, and it may be readily utilized as a means of expressing the fundamental concepts of the employer and the management, and frequently, what the workers are thinking as well. The plant paper is particularly valuable in this connection in organizations whose units are widely scattered, although its value is by no means limited to such cases. Of course, there have been many plant papers published which have made no attempt to cover labor policy and have been put out merely with the hope of, in some general way, increasing the good-will of the employees. While these are usually valuable, it is to be regretted that they do not further make themselves useful by considering the labor policy. Not much space is needed for this, and

most of the space in the magazine may still be used for educational, inspirational, and local-comment material. However, in order to form a background for the basic personnel policy of the plant, it is necessary that the plant paper be well edited, and of real interest to the employees.

Co-operation with outside educational agencies. Many business enterprises that do not have active educational programs of their own encourage their employees to attend classes in the regularly established colleges and evening public schools of the community. In some instances this encouragement only takes the form of approval by the supervisor or personnel department by noting such attendance on the employee's record. In other cases the company pays a part or all of the tuition on successful completion of these courses. In some instances these financial aids are given only when the courses taken are such that they may reasonably be expected to increase the efficiency of the employee in his present job or aid in his preparation for promotion.

In some communities where there are no regularly established evening schools employees are encouraged to take correspondence courses. Specialized correspondence courses may also be promoted even where regular schools are available. A word of caution should be made with reference to encouraging employees to take correspondence courses. A survey made by the Minnesota Employment Institute showed that only 6 per cent of the persons included in their study finished the course. Forty per cent gave up before the end of the first year and approximately 75 per cent dropped out before the end of the second year.

Methods of instruction. The methods of instruction in industry are as varied as they are in the organized schools, or even more varied. The different methods may in general be classified as follows: lecture quiz, laboratory, project, conference, correspondence, and various combinations of these. The lecture method may be used effectively for imparting information such as informing a group of new employees regarding the policies of the company. Slides and moving pictures may be used in connection with the lecture method as well as with other methods. The laboratory method is particularly valuable in imparting certain skills and other information relative to machines and materials. Correspondence courses may be used where the employees are scattered and special information is to be taught The correspondence method is the least desirable of all, but is the only practical method under some circumstances. The conference method is particularly suited to the instruction of adults and has been popularized in executive training programs since the World War.

"The Purpose of the foreman conference is to stimulate individual thought, develop initiative and the powers of attacking new problems on the part of the foremen by means of informal discussions in groups of about twelve men.

The foreman-conference method differs radically from the conventional teaching methods ordinarily employed. A chairman, or conference leader, presides over each group, but he is not a teacher; his duty is simply to use questions in order to develop free discussion among the members of the group and keep the discussion from deviating from the desired goal. By the conference method, foremen teach themselves.

"The conference method of foreman training is of particular value on account of its flexibility. The text material plays only a minor role, practical experience forming the background for every discussion."[1]

At a conference sponsored by the General Motors Institute of Technology, Mr. Frank Cushman of the Federal Board for Vocational Education, Washington, D. C. was the conference leader on the general subject of Methods of Instructing Foremen. Out of this conference attended by personnel directors and other key executives the summary presented in Table 6 was developed.

Training for specific jobs and promotion. In no other feature of industrial management is the size of the plant such an important consideration as in the organization and development of employee training. The size of the plant will often be the limiting factor which will determine whether this work should be undertaken, or, if undertaken, what its scope may be. Training work, although usually valuable, is always expensive, and it will not prove profitable on a large scale in small organizations, save for a very few highly specialized jobs. In every organization foremen, department heads, or specialists, such as time-study men, must instruct the workers in the performance of specific jobs. Such instruction merely modifies the previous training and experience of the worker in a way that will enable him to perform his tasks more effectively. Such training is a portion of the supervisory process and must always be carried on.

Inexperienced workers are continually applying for employment in tasks that require experience. Frequently these may be eliminated by the employment department, but often they must be hired and tried because of the scarcity of workers. Often workers, generally skilled in the trade, must be trained in the particular branch of the trade, if spoiled work, disabled machinery, or the risk of accidents is to be reduced to a minimum. Then there are great potential gains in training workers already employed, for advancement, and in training foremen and departmental supervisors toward a better understanding of the company and their jobs. These are the phases of a general training program, and they must always be developed with the present and prospective size and the general policies of the organization foremost in mind.

[1] Bulletin of Engineering Extension Division of Pennsylvania State College.

TABLE 6

COMPARATIVE VALUES OF DIFFERENT METHODS OF INSTRUCTION *

Types	Lecture	Text Book	Correspondence	Individual Reading	Conference
Usual purpose	Inspirational and informational	Information on new subjects or additional knowledge	Promotion, increase of wages	Advancement and pleasure	Better performance on the job
Who determines subjects	Lecturer, with or without advice	Author or authors	Author or authors; purchaser of course	Man himself	Leader suggests; men dispose of subjects
Fitting subject to plant conditions	Probably no; possibly 100%	In a general way	Same as textbook	Possibilities greater	O.K.
Type of thinking promoted	Passive	Depends upon instructor	Active	?	Active
Chance to ask questions	No	Yes	Yes, by mail		Yes
Size of group	No limit	Usually smaller than lecture	One man	One man	16–20 preferred
Probable lasting effect	Very limited	Better than lecture	Similar to textbook	What he gets probably sticks	Better than I, II, and III
Faculty exercised by foreman	Memory	1. Memory 2. Ability to refer and apply	1. Same as II	Same as II	Thinking ability

* *Conference Leader's Manual* to accompany *Department Management* (Flint· General Motors Institute of Technology), reproduced by permission of Major Albert Sobey, Director.

Apprenticeship-training. Apprenticeship as a vital part of the social and economic *mores* has largely passed from industry. Such training is found today only in the larger plants, which, because of the great number of all-round workers that they need, can afford to introduce training courses and stand the expense of training workers who may not remain with them. Thus, such companies as the Westinghouse Electric and Manufacturing Company, the Goodyear Tire and Rubber Company, the General Electric Company, and the Ford Motor Company have found it profitable to develop apprentice courses. In these are enrolled young men and boys fourteen to eighteen years old, or more, who are trained for three or four years, paid wages for hours of instruction, as well as hours of production, and then at the end of that time are graduated as qualified journeymen and given in some instances $100 or $150 and their kit of tools.

A special feature that differentiates apprentice-training from the training for operating a special production machine is the attempt to teach the apprentice the underlying principles behind the trade. It is immeasurably more fundamental than mere job-training. There has been a revival of interest in apprentice-training since the beginning of the depression. Jobs have been harder for young men to get and the more ambitious ones have turned to apprentice-training as a desirable way out. The federal government has established a permanent committee on apprentice-training and employers have come to realize that this program is particularly desirable in the training of men who will later develop into minor executives.

Vestibule schools. The tendency in industrial training has recently been to train for the task rather than for the trade. One of the most highly developed forms of such training is the "vestibule school," which teaches operations rather than principles. This is a preliminary training shop specially designed for instruction, through which new employees are taken before being allowed to work on the production floors. It came into particular favor during the World War period of 1917-20, because of the large number of workers engaged in occupations with which they had previously been totally unfamiliar. Sometimes this training takes place in a separate room and sometimes in the corner of the actual production floor, which is rather better where feasible, since it makes possible the immediate acclimatization of the new employee to the shop atmosphere of production.

The vestibule school has fallen into great disfavor since the War period. There are times when it seems to be the best type of training, for example, when the job is unusually hard to learn, as contrasted with similar jobs within the industry, or when instruction seems to be im-

possible in the shop because of unusual conditions of production. However, it has many disadvantages, a few of which are as follows:

1. No matter how great the attempt, it is difficult to reproduce actual working conditions;
2 It is difficult and expensive to have sufficient machinery of each type in the plant set up in the school for instruction purposes;
3. Because of the uneven demand for new workers, either part of the vestibule school is usually idle or workers are rushed through it without the desired training.

Training the worker in the shop. Most forms of employee-training involve the instruction of the worker on the production floors while engaged in the regular processes of production. In training in this manner, no additional equipment is necessary, but it is essential that the work be constantly checked to insure that training is actually being carried on. Such training is usually by or under the immediate supervision of the foremen. This is an ideal method of training under modern industrial methods, because the foreman, having been relieved of many of his previous duties, is left free for supervision and training work, his logical field. All foremen are not inherently successful teachers, but if they have as complete a knowledge of their work as may be expected of them, they may readily be trained to impart their knowledge to others. Foremen are often aided in instruction of beginners by an assistant particularly designated for that work, in case of large departments, or by designated workmen in smaller departments. Under the latter method it is necessary to reward the worker for giving the instruction. Success will usually follow training under the foreman, if it be made clear that this is one of his chief duties, and if means are provided for following up workers to see that they are, in fact, receiving training and are not being left to drift.

Training for promotion. The need for training for promotion arises from the need of men to care for an expanding program as well as for the normal replacements arising from deaths, retirement, "quits," or other factors in expected labor turnover. Any promotion program which may be adopted by a concern cannot be allowed to rest with the development of line-of-promotion charts. This is true particularly of promotion from one shop job to another. Means must be provided to allow for the training of deserving employees in tasks that are higher on the promotion scale. With the vestibule school this may be accomplished readily, and such a program allows for the utilization of this school during times when it might otherwise not be busy. Without the vestibule school it is necessary to sell the various foremen on the desirability of the training program, and to follow up the program by accurate records to see that

employees who are in fact successful are being prepared for advancement by their supervisors along the lines laid down by the promotion program.

The use of the system of understudies has been advantageous in some organizations possessing a high type of morale. This is especially true when the organization is expanding. The understudy system requires careful follow-up or it may exist in name only. Many workmen as well as supervisors are reluctant to train an understudy for fear he will take his job.

Training subexecutives, foremen, and supervisors. Subexecutives hold a new and very important place in industry today. Upon them devolves the task of directing wisely the huge mass of industrial workers. To them these workers look for guidance and for an interpretation of the policy of the company. To the employee the foreman stands for the management of the plant. The development of modern industry from a stage of craftsmanship and small shops to one of machine production carried on in vast buildings—often only one group of a chain of enterprises under the same management—has automatically made the foreman the interpreter of the management to the men as well as the director of production itself. In this dual capacity the foreman stands between management on the one hand and the rank and file of workers on the other—a peculiarly difficult and at the same time a powerful position. Among his responsibilities are the standard of production, the quality and quantity of work; indeed, upon his shoulders rest not only the stability and effectiveness of the industrial fabric, but the fulfillment of the aspirations of thousands. In many respects the training of subexecutives is more important than the training of workers in the mechanical skills, because executive and supervisory abilities are relatively scarcer than mechanical abilities.

Much can be done to train these subexecutives for their tasks merely through the method of organizing the enterprise, as was explained in considering the committee idea in organization.[2] Much more can be done through intelligently handled plans of foreman and subexecutive training. Such training must primarily aim to develop the qualities of leadership of the foreman or subexecutive. It must broaden him, and at the same time develop such qualities of analysis within him that he may be able to visualize his job as he was unable to do previously, and as no training course can enable him to do. One of the most important aims of such training must be so to develop the foreman that he will be able to find ways and means of winning the confidence of those under him to an extent far beyond his previous ability. Regardless of the formation and operation of a personnel department, which will endeavor

[2] See Chapter VII.

to win the complete confidence of the working force, it is but natural and desirable that a large proportion of the workmen will continue to look to the foreman as the means of contact with the firm. Thus, the foreman will be likely to occupy a natural place in the esteem and confidence of the workers which cannot be duplicated by any artificial relationship that may be established.

Foreman and subexecutive training should develop in these members of the organization the ability to analyze themselves and to see better wherein they are living up to the important trust which has been placed in them. It should result in encouraging the subexecutive to see the plant as a whole and to see his relation to it. Furthermore, it should so develop these members of the organization as to qualify them for advancement to positions of greater authority, as these become available.

Caution must be exercised in the methods of training which are used. Subexecutive training is another one of those management ideas which has been both grossly over-used and grossly misused. The training must be carefully developed, lest it result in the swelling rather than the growing of those who are being trained. This is likely to result from too much unstinted reiteration of the great importance of the subexecutive to the business. Some types of men can listen to discourses of this kind for a long while and still see relationships. Others will merely go back to the shops more fully convinced than ever of their own importance. Furthermore, if the inducement of advancement is held out by the firm as the bait to attract the subexecutive to the training, there is likely to be much disappointment when it is realized that for every possible promotion that may exist, there are now a number of trained candidates. Last but not least, managements must be careful that they do not encourage the enrollment of their subexecutives in training courses advocating policies which the management is not ready and willing to see carried into effect. Foremen, particularly, who receive this training and who find themselves both unable to advance to higher positions and unable to put into effect the methods which they have learned, are likely to develop a very bitter attitude toward those higher up in the management. They are soon likely to feel that it is the management, not they, that needs the training (which is unfortunately sometimes the case).

There have been two general types of subexecutive training developed, that which provides for discussions of methods, policies, and trends by the supervisory force of one plant at meetings held at the plant, and that which provides for enrollment in general groups of supervisors from a number of organizations. The first plan is by far the more desirable, where it can be adopted, but small concerns, located in large industrial communities, will find much to attract them in the latter method. In the one-plant groups there is an opportunity provided to relate all dis-

cussions to the problems of the plant and the individuals who compose the group. Where such groups do not provide the training which it is desired that any particular supervisor have, such a person may be individually advised to join some general group, or some particular home-reading course, trade school, or evening course. To secure the benefits of real training, however, it is essential that any groups organized within the plan be homogeneous, in order that topics of direct interest to all may be discussed. Several training groups may well be organized. If large groups, composed entirely of executives, are to be formed, it is necessary that the material discussed be confined to general matter, or matter that involves the co-ordination of activities of nearly all those present. Such plant groups can often be handled to best advantage as part of a foreman's club, or similar activity.

Group training courses, which are available in varying numbers depending on the size of the town in which the plant is located, and which may be recommended by the management, include Y.M.C.A. courses, university evening and extension courses, and courses maintained by groups of plants acting jointly.

The procedures used in instruction have been discussed under the heading of *Methods of Instruction.*[3] The conference method is recommended as being particularly suited for training foremen and sub-executives. The subject matter for most of the earlier phases of the training will be selected from actual problems arising in the particular plant, such as quality control, securing suggestions from employees, good plant housekeeping, accident prevention, the foreman as a leader of men, the foreman as a teacher. The more intimate the subjects of discussion, the more valuable will be the results. The accompanying chart (Fig. 113) illustrates the type of subject that makes for progress. It was worked out during a conference of foremen at the plant of the Everett Pulp and Paper Company, Everett, Washington. It represents the amount of supervision, on a scale of 10 as complete, that should be exercised by the foreman over the operations performed by the digester man in the pulp mill. The heavy line connects the amounts which the particular foreman thought were necessary before discussion, and the dash line connects the amounts which were finally agreed upon by him as correct after discussion and argument. Such meetings, if properly led, will result in real foremanship training.

In addition to material relating to the functions of foremen and the manner of handling their work, general material on economics, the policies and history of the company, and problems of the industry are introduced in the most complete training programs.

[3] See p. 341.

Supervision of training. In large plants all training may well be placed under the direction of a supervisor of training, who may report to the director of personnel. In smaller plants, direction of training will probably be placed under the employment department or the service

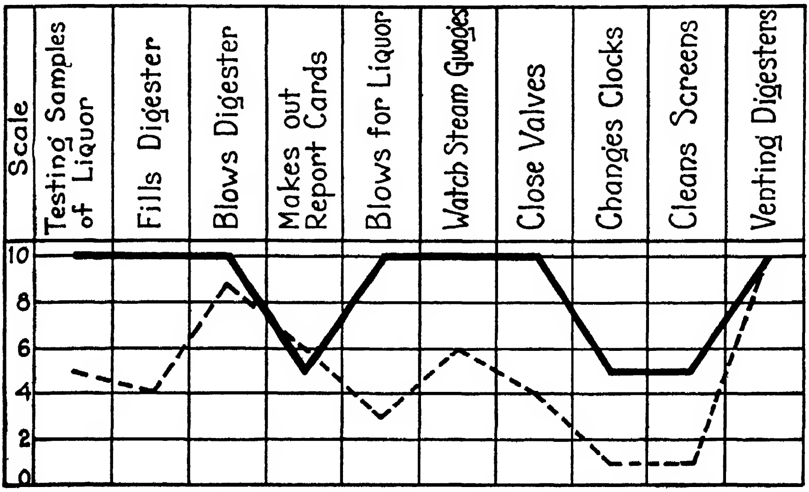


FIG. 113. Chart Showing Relative Importance of Supervisory Duties, Everett Pulp and Paper Co., Everett, Wash.

department. At any rate, it is largely a personnel function, although it deals so intimately with production. In it are involved numerous major relationships of the management and the workers, including fitness for the job, promotion, and interpretation of plant policy. As such, it is primarily a personnel function, at least, to the extent of follow-up. Actual instruction may well be in charge of the production force itself.

CHAPTER XXVII

INDUSTRIAL SAFETY

The need for safety in industry. Sixteen thousand five hundred workers in industry within the United States were killed during 1938 while in the course of their employment. During the same year 1,400,000 suffered non-fatal accidents of varying degree which made them miss days of employment, frequently referred to as "lost-time accidents." What does this mean in terms of production delays, of injured organization morale, of increased costs and narrowed markets? The overhead cost of insurance against occupational accidents alone amounted to approximately $100,000,000. This sum does not include the amount of claims paid which are reported by the National Safety Council as a part of the wage loss, and medical expense which respectively amounted to $470,000,000 and $75,000,000 for the year 1938.[1] Is it to be wondered at that employer and employee unite in the demand that all in industry become active allies in the accident-reduction army? It is the one phase of industrial management of which no one can question the desirability.

The organized accident-prevention movement. While the organized safety movement is comparatively new in industry, having reached sizable proportions only since the World War, it can point to demonstrated achievements of great magnitude. Its rapid growth has been due partly to its humanitarian aspects, partly to the demonstrable fact that accident prevention pays, and partly to an effective national organization, The National Safety Council.

Casualty insurance companies carrying compensation insurance, through schedule rating of individual risks and through inspection service, have proved of inestimable assistance in accident reduction. Their effort has shown the great need for more definite analysis of accident causes as a basis on which the organized accident-reduction movement may rest.

The National Safety Code Program, sponsored by the best engineering minds in the country and reaching into all states and all industries, proposes standardization of codes and regulations. This ultimately must be of enormous benefit to builders and users of machinery at the same time that it insures uniform attention to all like hazards, promotes work-

[1] See National Safety Council, Inc., *Accident Facts, 1939 Edition,* p. 57.

able codes for jurisdictions which cannot afford to prepare their own, and consolidates the experience of the larger industrial states which have dealt with these engineering problems in many thousands of establishments.

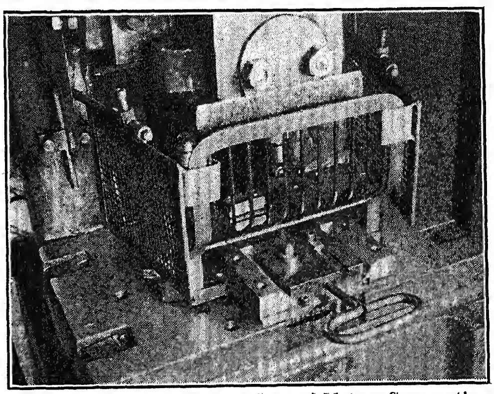
The development of these national codes is under the direction of the American Engineering Standards Committee, with all interested groups co-operating. The National Safety Council, The Bureau of Casualty and Surety Underwriters, or the American Society of Mechanical Engineers may direct the development of a national safety code. The Federal Department of Labor and state labor departments add their experience and effort to the development of these codes.

Does accident prevention pay? Mr. G. A. Orth, Manager of the Safety Department of the American Car and Foundry Company, has said: [2]

"Hitherto, the two chief factors considered in a producing organization have been material [including machinery] and personnel [including organization]. To these I would now add a third factor, namely, accident prevention. Accident prevention directly affects both the material and the personnel; and it affects them in four directions:

"(1) *Increased* Production.
(2) *Decreased* Overhead.
(3) *Decreased* Labor Turnover.
(4) *Saving* in Money Compensation.

The physical side of accident prevention. Without having mechanical hazards guarded adequately, no plant can expect to win the workers' co-operation in educational programs for accident reduction. The necessity of adequate illumination as a safety factor was discussed in Chapter XI. Other phases of physical dangers include power-transmission equipment, points of operation on machinery, slippery floor and stairway surfaces, and danger to the eyes from flying particles.



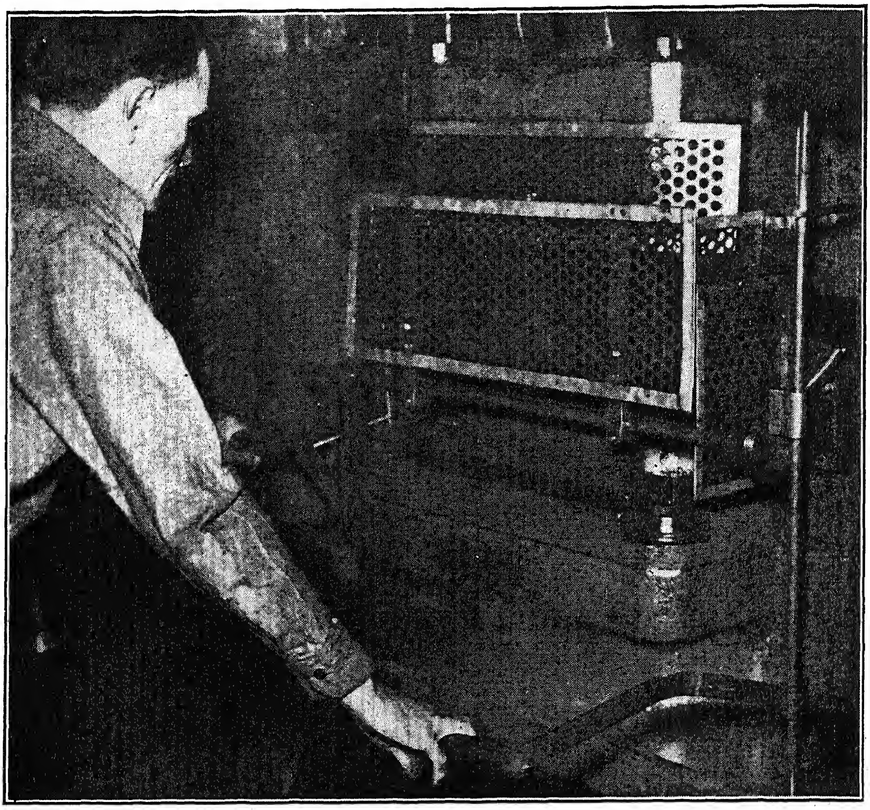
Courtesy General Motors Corporation.

FIG. 114. Basket Guard for Punch Press, Ternstedt Manufacturing Co., Detroit. (See handle for feeding parts into press.)

Point-of-operation guarding is coming to be of great importance, because, while power-transmission machinery has come to be guarded well, little has been done with points of operation, except the first

[2] *Annals*, January, 1926, p. 22.

two of the following three classes: (1) accidents from flying particles—emery and other abrasive wheels; (2) accidents due to contact with the moving parts of machines, as on punch presses; (3) accidents due to kick-backs of work, or parts of the machinery which move flying through the air. Examples of the third class are lumber kicking back from a circular saw and shuttles flying from the loom. Figure 114 illus-



Courtesy National Safety Council.

Fig. 115. Punch-press Guard Requiring Both Hands to be Occupied before Press Will Operate.

trates an effective point-of-operation punch-press guard. Other types of guards (Fig. 115) sweep the worker's hands away from the descending tool and require him to have his hands on two separate levers before the press will trip. Figure 116 illustrates a shuttle guard that effectively keeps the shuttle from flying as it passes across the loom. This saves smashes of the warp as well as injury to the operator. Figure 117 shows a properly guarded grinder with an individual motor drive, thus elimi-

nating the necessity of guarding the belt and pulley. Observe the use of goggles even though the grinding wheel is well guarded.

Accident-prevention by making floors and walk-ways safe is a big factor in the industrial accident toll. A study by the National Electric Light Association indicated that over one-third of all falls occur on the level and on stairways, and not from poles, scaffolds, or other equipment.

Adequate eye protection will save a large percentage of the eyes lost in industry each year. There is great need for having goggles

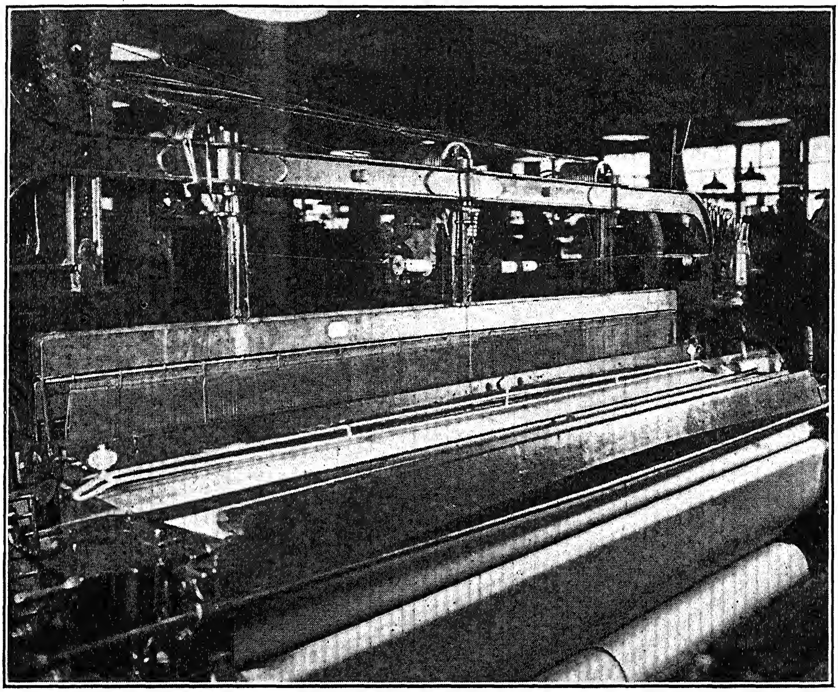


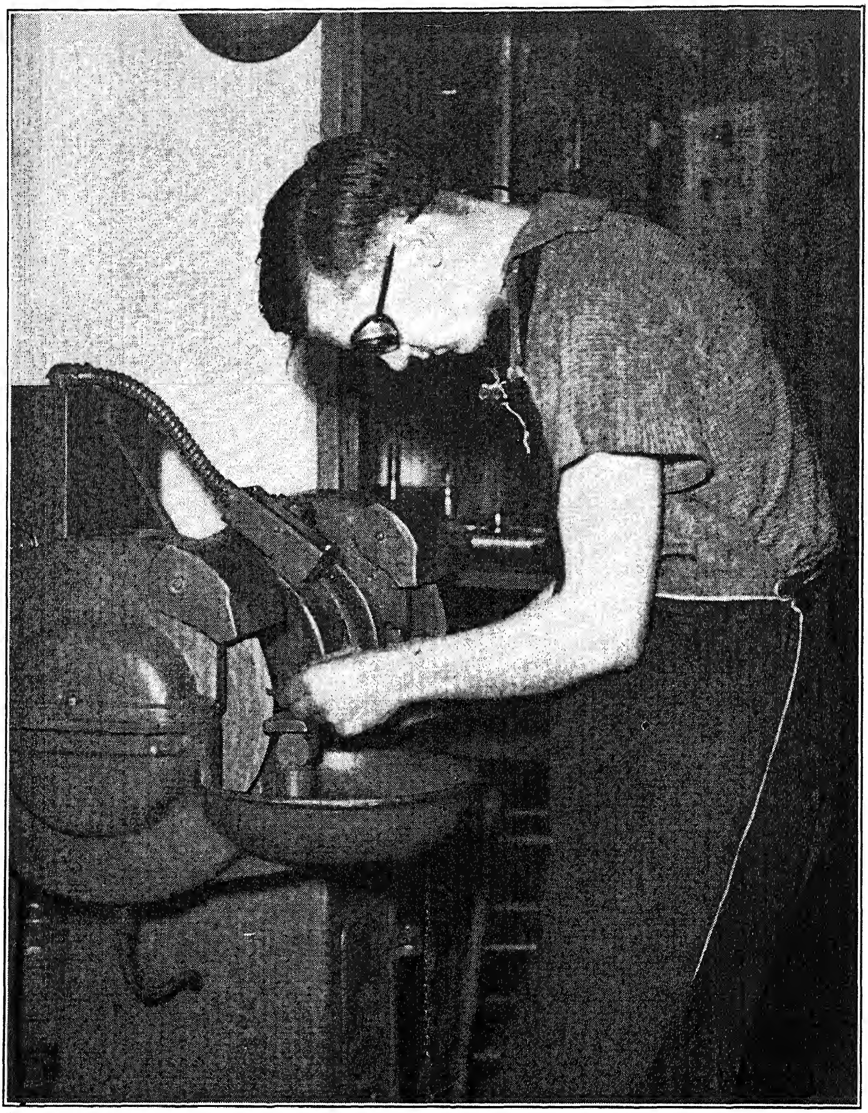
Fig. 116. Loom Equipped with Shuttle Guard.

handled by someone familiar with their use. This person should appreciate what constitutes a fitted goggle so that the wearer may, in addition to obtaining protection from the eye hazard he is compelled to encounter, be given the assurance of a feeling of security behind the devices.

Occupational diseases.[3] Compensable disability arising from occupational diseases is relatively insignificant in comparison with accident compensation. In the state of New York during the five-year period

[3] See National Safety Council, Inc., *Accident Facts, 1939 Edition,* pp. 12 and 22, for data supporting the statements made in this paragraph.

1933-1937, one out of a hundred compensable cases was assigned to disease. For a seventeen-year period during which Wisconsin paid com-



Courtesy National Safety Council.

FIG. 117. Safe Practice in Grinding, Lane Technical High School, Chicago.

pensation for occupational diseases, it paid out $1,600,000, which represented in round numbers only 3 per cent of the total compensation paid.

From the standpoint of seriousness in New York the average award for disease was for 27 weeks, in comparison with 29 weeks for accidents. However, by eliminating the cases involving skin diseases the occupational disease awards averaged 40 weeks.

The types of occupational diseases vary with the industry and in some instances with localities. The distribution of occupational diseases in New York was as follows: 48 per cent, dermatitis; 18 per cent, blisters or abrasions; 9 per cent, lead poisoning; 6 per cent, poisoning from benzol or benzine derivatives; 6 per cent, bursitis or synovitis; 1 per cent, acid poisoning; 1 per cent, carbon monoxide poisoning; and 11 per cent, miscellaneous. Wisconsin attributes more than 95 per cent of its occupational diseases to silicosis.

Each industrial enterprise should study its experience and concentrate on eliminating the causes of its occupational diseases. It requires close co-operation between the medical service, operating department, and engineering and process division to get effective results. Society is becoming keenly aware of the broader implications of occupational diseases. There are individual differences in the workers' reactions to occupational diseases, just as there are individual differences in reacting to the pollen of ragweed. A careful check-up by the medical department may readily detect many individuals not suited to individual occupations. An equitable transfer or other adjustment in such cases will tend to reduce occupational diseases.

The use of facts in promoting safety. Before discussing *educating the worker in safety,* it will be well to consider some facts relating to industrial accidents and the importance of basing any program on the analysis of facts.

1. Trends in frequency and severity of accidents. The frequency rate of industrial accidents is the number of disabling injuries per 1,000,000 man-hours of exposure. The severity rate is the number of days lost as a result of disabling injuries per 1000 man-hours of exposure, including charges for permanent disabilities and deaths.[4]

Figure 118 shows the decline in both the severity and the frequency of industrial accidents since 1927.[5] Frequency has declined more than severity, but both have made a remarkable showing. Data are available by industries from which trends for each industry may be established and the individual manager may measure his own performance against that of his industry as a whole. The table given below shows the frequency and severity rates for various industries for 1938.[6]

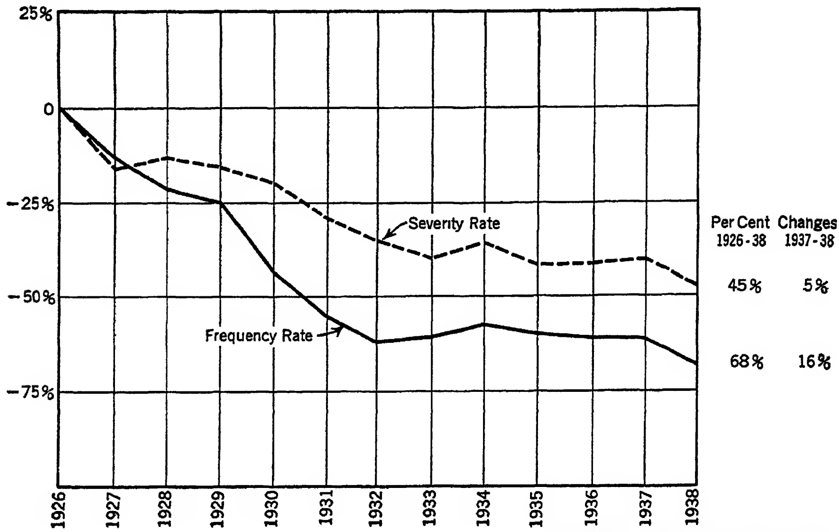
2. Types of compensated occupational accidents. Figure 119 below

[4] National Safety Council, Inc., *op. cit.*, p. 71.

[5] *Ibid.*

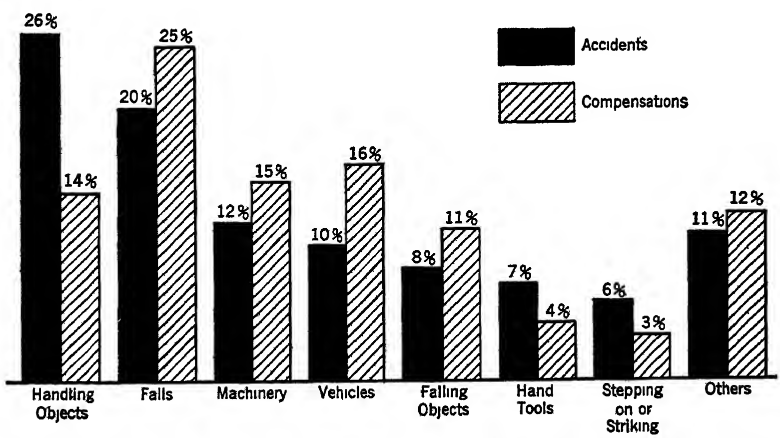
[6] *Ibid.*

shows the distribution of compensated industrial accidents. This same information is available by industries and may well serve as a challenge



Courtesy National Safety Council.

FIG. 118. Accident Frequency and Severity Rates. Source: Reports of Industrial Establishments of the National Safety Council Taken from 1939 edition of *Accident Facts.*



Courtesy National Safety Council.

FIG. 119. Types of Compensated Occupational Accidents. Source: Five State Labor Departments on Industrial Commissions; one 1931 and four 1935 reports. Taken from 1939 edition of *Accident Facts.*

to an individual enterprise. It also points to places where effective work may be done.

TABLE 7

ACCIDENTAL INJURY RATES BY INDUSTRIES, 1938

Industry	No. of Units	Man-Hours (thousands)	Frequency Rate		Severity Rate	
			Rate	Rank	Rate	Rank
All Industries *	4497	5,502,520	12.18		1.53	
Automobile	136	390,421	7.66	7	.74	9
Cement	116	38,198	4.61	2	2.44	25
Clay products	70	13,984	13.37	19	.87	12
Chemical	307	260,522	7.93	8	1.23	18
Construction	209	261,419	24.93	27	3.24	27
Food	422	209,534	15.55	22	1.16	16
Foundry	114	57,761	18.42	25	.88	13
Glass	34	52,561	8.18	9	.60	6
Laundry	40	15,560	7.33	6	.61	7
Lumbering	79	45,798	46.38	30	3.75	28
Machinery	291	512,527	8.29	10	.70	8
Marine	61	169,509	13.02	18	1.97	23
Meat packing	89	172,613	25.57	28	.76	10
Metal products (misc.)	179	151,664	10.05	13	.80	11
Mining	174	64,291	37.00	29	10.84	30
Non-ferrous metals	58	111,626	8.32	11	1.95	22
Paper and pulp	244	184,991	15.33	21	1.18	17
Petroleum	139	659,467	12.64	17	1.59	20
Printing and publishing	38	24,371	8.95	12	.24	2
Public utilities	625	699,135	11.37	16	1.97	24
Quarry	114	11,445	10.66	15	4.62	29
Refrigeration	43	17,521	24.60	26	2.51	26
Rubber	38	85,388	6.92	5	.58	3
Sheet metal	190	129,936	10.53	14	1.12	15
Steel	130	497,297	6.56	3	1.84	21
Tanning and leather	48	30,434	17.38	24	.59	5
Textile	156	193,122	6.73	4	.59	4
Tobacco	29	26,227	2.10	1	.23	1
Transit	183	313,771	14.58	20	1.57	19
Woodworking	100	29,924	15.87	23	.90	14

Source: Individual company reports to the National Safety Council. Rankings should be considered indicative rather than exact because there is considerable variation from industry to industry in the proportion of companies which maintain accident records and send reports to the National Safety Council. Thus, in the above table, the information given for such industries as Cement, Petroleum, Rubber, Steel and some others, is based on the experience of a large proportion of all employees working in the industry, whereas in other groups such as Tobacco, Laundry and some others, the Council receives reports from a relatively small proportion of the entire industry. The National Safety Council publishes a separate pamphlet for each industry, giving details of the year's accident experience.

* Includes miscellaneous industries, and corrected for certain duplications.

3. Causes of accidents. The National Safety Council reports that about 87 per cent of all work accidents involve some unsafe act, and that 78 per cent have some mechanical or material cause.[7] In approximately 80 per cent of the unsafe acts, some definite personal cause was responsible. Mechanical causes accounted for about 20 per cent of the total accidents. The breakdown of the *unsafe acts, personal causes,* and *mechanical causes* given in tabular form below points definitely to the responsibility of management for proper selection, training, and discipline of its employees, as well as to management's responsibility for removing most of the mechanical causes.

TABLE 8

CAUSES OF ACCIDENTS*

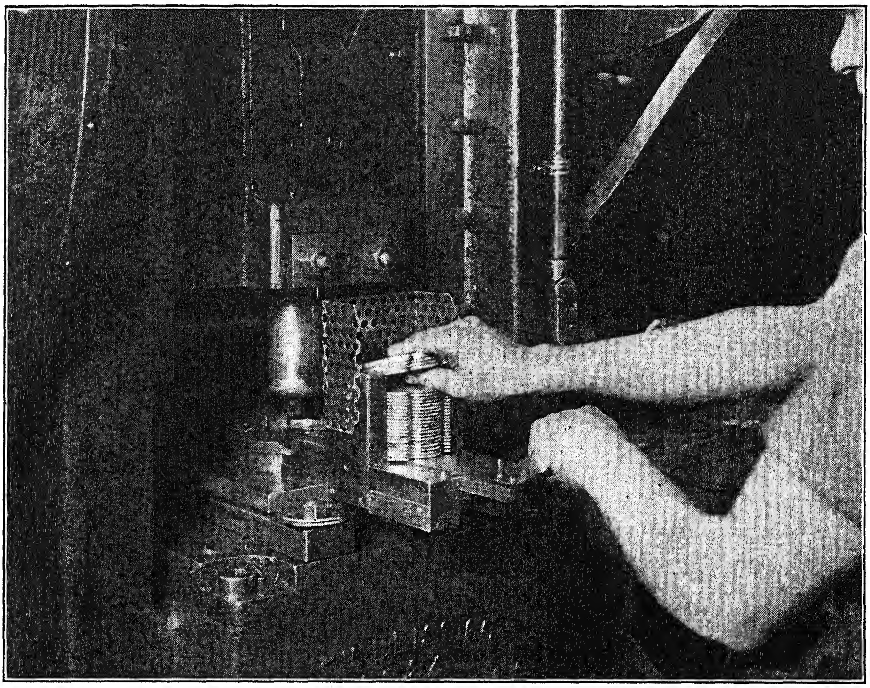
Unsafe Acts	%	Personal Causes	%
Unnecessary Exposure to Danger	26	Lack of Knowledge or Skill	48
Improper Use of or Unsafe Tools	16	Improper Attitude	31
Non-Use of Safety Devices	15	Bodily Defects	3
Unsafe Loading or Arrangement	10	No Personal Cause	18
Operating at Unsafe Speed	7		100%
Working on Moving Equipment	6	**Mechanical Causes**	
Improper Starting or Stopping	5	Hazardous Arrangement	34
Other Unsafe Acts	2	Defective Agencies	18
No Unsafe Act	13	Unsafe Apparel	15
	100%	Improper Guarding	9
		Improper Light or Ventilation	2
		No Mechanical Cause	22
			100%

* Source: National Safety Council, *Accident Facts*, 1939 Edition, p. 19

4. Mechanical devices. Frequently guards are not used by the workmen because they slow down their production. Piece workers do not like to have their production slowed down even though the rate is supposed to compensate for the safe practice. Some of the safety devices have been inadequately engineered and have placed an unnecessary burden on production. On the other hand, careful engineering may change a hazardous operation to a safe one and increase production at the same time. Figure 120 shows a device that is carefully constructed

[7] See National Safety Council, Inc., *Accident Facts, 1939 Edition,* p. 19, for a detailed discussion of the data on the Causes of Accidents.

along both safety and production lines. The safety engineer should not sacrifice the workers' physical safety for increased production. On the other hand, he should consider production requirements and harmonize the two. The installation of an automatic feed, using strip stock, not only increases the safety factor of a punch press operation but also increases production. The time and motion study department should



Courtesy National Safety Council.

FIG. 120. A Fixture Constructed along Both Safety and Production Lines.

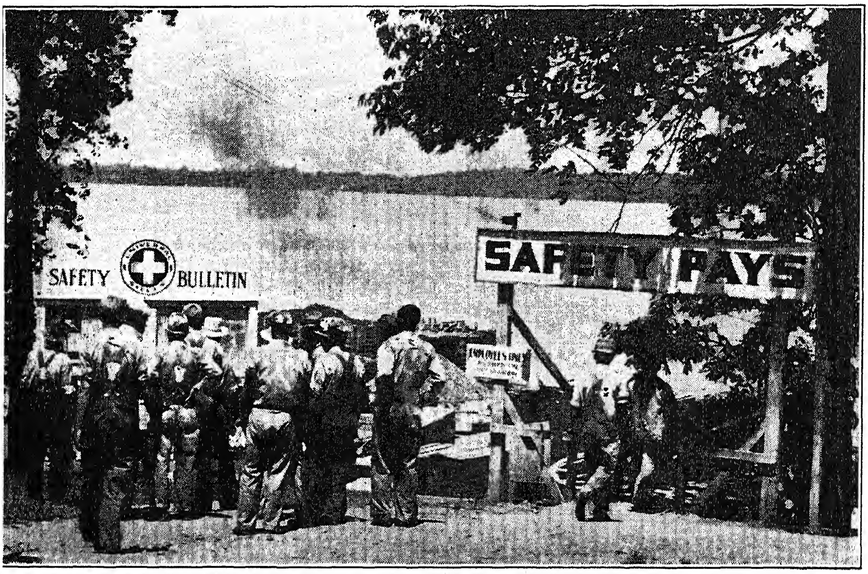
be a strong ally of the safety department. Their long-run interests are identical in many respects.

5. *Proper safety standards* must be based on facts the same as all other management standards. It is essential that accurate records of each accident be kept and that these be in terms comparable to those set up by the National Safety Council. Periodic compilation of the safety performance will indicate trends and serve as a guide in the expenditure of funds and concentration of effort. Safety is largely a state of mind, but after all, a favorable state of mind must not only be created but constantly guarded or it may easily change.

Educating the worker in safety. Physical conditions having been attended to, the education of the workers in safetv will maintain safe

working conditions, and will result in every worker's being safety conscious all the time he is at work.

Departmental or group safety committees should be organized and the competitive spirit between departments aroused. An active safety committee will work strenuously to have a better record than its neighbor, and, once aroused, the men learn how to put the doctrine across. Vigorous and pointed safety bulletins should be liberally posted and *frequently changed*. Plant cartoonists will find here an admirable field in which



Courtesy National Safety Council.

FIG. 121. Safety Bulletin Board at Entrance to Construction Job at Wheeler Dam.

to work and the fact that cartoons and bulletins are homemade and cite home events will increase their punch.

The plant magazine forms an excellent means of putting safety across to the workers. Nearly all plants which have safety programs of any size utilize safety posters of some kind. The National Safety Council has an elaborate poster service, and most of the casualty insurance companies include a poster service as one of the items in their workmen's compensation policies. Figure 121 shows the use of the "Safety Bulletin" board at the entrance to the construction job at Wheeler Dam. Advertising is the silent salesman of the safety program just as it is of a commercial product.

Figure 122 illustrates a safety meeting typical of those held a few years ago in our large Eastern steel mills. The tendency today in

many plants is toward group safety meetings smaller than the one illustrated.

One of the direct results of safety education is to reduce the number of infection cases from accidents by having the injured worker report

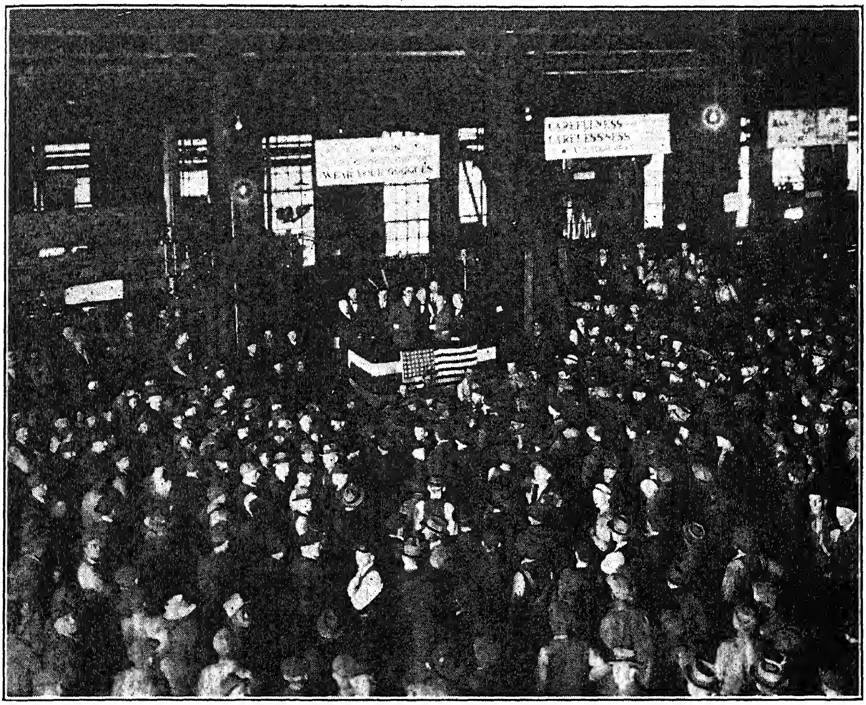


FIG. 122. A Safety Meeting in the Shop During Working Hours. Duquesne Works, Carnegie-Illinois Steel Corporation.

promptly to the dispensary for treatment. A sympathetic doctor and nurse will work wonders in persuading men to come to the hospital for first-aid, and first-aid prevents infection. Persuasion, as well as regulations, should be used in this direction.

PART VI

WAGE PAYMENT—BASIC RELATIONS OF EMPLOYER AND EMPLOYEE

CHAPTER XXVIII

THE BASIS OF INDUSTRIAL WAGES

The power of wages. The reasons for the importance of wage payment in industrial management are readily apparent when the effect of the setting of the wage upon the life of the worker is considered. Ordinarily, the scale of living of the worker is, at any time, directly dependent upon the amount and the purchasing power of the wage which he is receiving. Usually he has no accumulated surplus upon which to draw and no other sources of income besides his daily wage. Therefore, the wage that is paid places or lifts restrictions on the home life and recreation of the worker and reaches into his personal life in a way unknown to any other management factor.

Wages may be looked upon as the inherent source of power which makes the turbine representing the organization revolve. The higher the wages that are paid, up to a given point of maximum return, the more effectively the organization will operate. The smaller the amount of wages, or inherent power, that is allowed to flow through the organization, the less developed power may be expected as a return. But the utilization of this great power force is not simple. Wages paid cannot be considered in the absolute, but must be considered relatively to those paid by other companies in the same field of business, or in the same community, and in relation to the economic needs of the workers.

Real wages vs. monetary wages. In discussing wages it is important to distinguish clearly between *real wages* and *monetary wages*, particularly when comparing wages of one period with those of another or comparing two different locations with different wage levels. From the standpoint of the worker, or his standard of living, the real wage is the vital factor. The *real wage* is measured by the goods and services that can be purchased with the monetary wage. The monetary wage is represented by the actual monetary units that the individual receives. A worker is in a relatively worse position, who receives $48 per week

and has to pay $60 per month house rent with other living costs proportionate, than another worker who receives only $36 per week and pays $30 a month for house rent with other living costs correspondingly low. Most executives have recognized this situation, but many labor leaders have either refused to recognize it or did not comprehend its significance.

The satisfactory wage. The determination of the amount of wages paid under our industrial system has rested primarily with the employer in the past. This was especially true prior to the general acceptance of collective bargaining. The wage, nevertheless, had to be satisfactory to the employee, and is limited by its acceptability to the employee individually and collectively, at times by the general attitude of the community, and possibly by some governmental or state action[1] Thus, instead of a basic wage which is set entirely by the employer, there is found a basic wage which is ordinarily termed "right" or "satisfactory." There can be no general definition of the meaning of a "satisfactory" wage, inasmuch as its limits will differ so greatly under varying conditions. However, it can be stated that a satisfactory wage must bear the scrutiny of employees and, at times, of the community. The general attitude of the community will not be likely to affect an individual plant except in cases where that plant is the main or basic industry of the community, or except in cases of localized industry where a large portion of the community, other than those who actually are at work in the plant, secure their livelihood as a result of the wages paid within the factory.

Not infrequently we hear satisfactory wages spoken of as though they were "just" wages. In order to indicate the inaccuracy of such an idea and also to prevent confusion when a so-called "just" wage is attacked by the employees, it will be well to examine the fundamentals of what constitutes "just" wages.

What are just wages? Any true idea of just wages must necessarily include a concept of payment to wage-earners on the basis of their contribution[2] to industry, as well as some concept concerning the right

[1] The Fair Labor Standards Act was passed by Congress and signed by the President June 25, 1938. This Act attempts to establish minimum wages and maximum hours for industry engaging in interstate commerce. Some of the individual states have similar laws.

[2] This concept is not universally held by students of ethics or economics. The communistic philosophy has frequently been expressed, "To each man according to his needs and from each man according to his capacity" More recently in Russia it seems for practical purposes to be, "To each man according to his performance and from each man according to his capacity." (See Z. Clark Dickinson, in *Compensating Industrial Effort,* The Ronald Press Company, New York, 1937, pp 65, 84, 134n).

to a fair living of an individual engaged in the productive process. The contribution of an individual or, in other words, his "productivity," has never been satisfactorily measured under our present industrial system, and it is questionable whether it can be measured. Our whole life is so complex, and the relations of one person to production are so inexact, that it becomes practically impossible to determine the extent to which he or she has added to the goods of the world. Prior to the factory system, it was more nearly possible to arrive at some concept of the productivity of an individual, but the factory worker of today is performing but a small part of the production of the article on which he is working. The machine on which he works and the building in which he works have not only been furnished and designed by the employer and the management, but have in the first instance been created by other workers. A knitter working on a complex knitting machine contributes much to production of the finished product which comes off that machine. The question remains, how much of the production is made possible by the workers in another factory far removed, who made the knitting machine? The economic theory of marginal productivity is helpful in theoretical discussions, but it is difficult to apply on a large scale to changing industrial conditions. Our idea of justice in the abstract must be tempered by practical considerations in its application to social conditions.[3]

From the worker's point of view in the United States a just wage must be either high enough to maintain the American standard of living or the market rate, whichever is greater. Management in general would subscribe to this statement of the just wage with the proviso that it is the competitive market rate, not one established by a non-economic means.

Presumably, regardless of the productivity of the individual, there is a point below which wages must not go, in order that the individual and the persons dependent on him may survive. This is seemingly the lower limit of a just wage but, in particular cases, even this lower limit must presumably be cut under if, for the moment, the industrial establishment in question is to survive. There are certain ways in which a given wage may be regarded by those intimately concerned with it which aid in determining whether or not that wage approaches a just wage. Probably that is as far as anyone can go at the present time.

Measurements which aid in considering the justice of a wage. There are two measurements which aid in the determination of this approach to justice. The first is that the wage must represent the results of an honest effort to divide the product of industry on a fair basis. The wage

[3] See Frank C. Sharp, and Philip G. Fox, *Business Ethics*, D. Appleton-Century Co., New York, 1937, pp. 181-194, for an interesting discussion of the ethics of a fair wage.

which is paid because the employment manager calls up a manufacturers' association on the telephone to find out from the secretary what "is being paid for a given class of job" at a given time does not represent any such effort. On the other hand, many organizations have wrestled with the problem and have come to conclusions which indicate that justice is being approached.

The second measurement is that the wage must command the support of all groups connected with the industry and of the community at large. If this is the case, it may be presumed that the wage is approaching a just wage. However, because of all the factors which have been described, it is better to think of the proper basic wage in industrial plants as being a *satisfactory* wage rather than a just or a fair wage.

The bases of satisfactory wages. There have been set forth three main bases as those which determine the satisfactory wage. Certain individuals have pointed to each of these as being the true base which sets the wage. These are supply and demand, the cost of living, and individual productive capacity. It is probable that in most instances all three aid in the determination of the basic wage rate, but no single one alone sets the rate. Supply of and demand for a given type of labor unquestionably have a large influence on the wage paid in most plants in the moderately long run. The workers, through organized labor and its attendant policies of the closed shop, restriction of apprentices, and elimination of overtime work, have sought to limit the supply of workers. As either the employer or the employee gains the upper hand in connection with demand and supply for workers, wage rates are seen to fluctuate. This does not imply that rates are reduced immediately when the labor supply exceeds the demand and the unemployed worker would be glad to secure employment at a lower wage. The "going rate" in a community tends to be perpetuated for some time after a change in the supply of labor.

In the long run wage rates tend to be set largely on the basis for which the worker can be secured, that is, what he can get elsewhere in the same community. Large organizations having plants in different cities pay different wages in each plant for the same work, depending upon the wage levels in these communities. Factories that use supply and demand as the main or only basis for payment of wages usually are the first to decrease their wages in times of depression, and the first to be forced to raise their wages in times of increasing prosperity. Base wage rates which are set entirely on this policy imply fundamentally a policy of drift.

Cost of living as a factor in wage payment. The cost of living has gained increasing attention as a means of fixing base wages. The idea involves a decrease or increase in the basic wage dependent on the rise

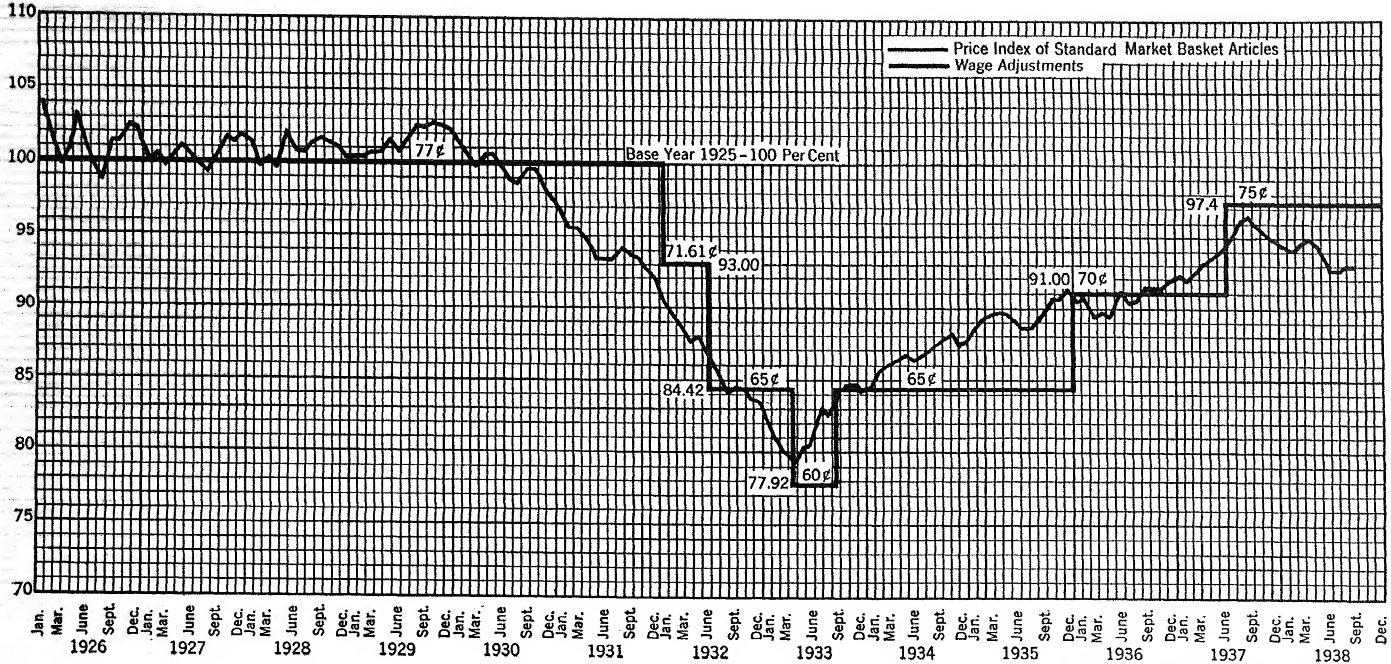
or fall of commodity prices and other factors which influence the budgets of individual workers. Cost-of-living statistics have been collected on an increasingly large scale and have been used by an increasingly large number of organizations which are attempting to set satisfactory wage levels within their plants. Although cost-of-living figures are satisfactory as a check on base rates, nevertheless one of the most unsatisfactory features of them is that they are ordinarily based on the "average family." This usually consists of a man and wife and two or three children. The position of the single man, or the man with seven children, is thus thrown into question, if these cost-of-living figures are extensively utilized. A number of plants utilize figures of the Bureau of Labor Statistics, Department of Labor, of the United States government.

One of the most widely publicized programs of adjusting wage payments to meet changing costs of living is that of the Philadelphia Rapid Transit Company. Figure 123 shows the wage chart for trainmen in comparison with the "market basket" index. This program was used successfully for several years. "With the advent of the National and State Labor Relations Acts and the interpretations and decisions of the National Labor Relations Board and the Federal Court, the company concluded, effective June 1, 1937, that it could not further conduct collective bargaining with the employees under the present Co-operative Plan. However, the Market Basket survey is still made each month and is kept on file for the use of the employee or employer. The last wage adjustment was also made June 1, 1937. Conditions have not warranted any change since that time. The system used is quite simple. The arithmetical average of the prices charged for the commodities in the local stores is weighted by given quantities. The resultant costs are compared with the costs of the same or similar commodities in the base year 1925, and an index number for each group is thus obtained. The percentage change is, in turn, weighted by the group weight and the sum of these changes determines the Market Basket index."[4]

Any thought of using cost of living as a basis of industrial wages must include the willingness to increase wages as the scale of living increases, if the wage scale is to be successful. There is no outstanding difficulty in the way of recognizing the fact that the wage level must rise in conformity with a general rise in the standard of living. As a matter of fact, living standards rise very gradually and not by sudden spurts. The entire program requires mutual confidence on the part of both men and management.

Productive capacity as a basis for wages. Individual productive capacity cannot serve wholly as the basis for setting wage levels. It

[4] Reported to the authors in a letter August 18, 1938, by Mary A. G. Welsh, Statistician—Market Basket Division, Philadelphia Rapid Transit Company.



Courtesy Philadelphia Rapid Transit Co.

FIG. 123. Philadelphia Rapid Transit "Market Basket" and Wage Chart. The September 1938 Index is 93.2, a decrease of 6.8% from the base year 1925. The changes are: Miscellaneous increased 0.2%. The decreases are: Food, 3.7%; Clothing, 0.6%; Housing, 1.4%; Fuel and Light, 0.8%; Furniture, 0.5%. September 1938 decreased 3.4% from September 1937.)

can be viewed as a partial aid in setting relative wage rates, and all of the work in job study and in the development of particular wage-payment systems which has been lately carried on in industry had this end in view. If a sales manager is to be employed, it is to be presumed that he will be paid at a higher rate than a laborer in the shop. This is due not entirely to supply and demand, but partly to the concept of individual productive capacity. This factor, therefore, influences very largely all wage rates which are set, but any thought that it governs them entirely will come back to the idea that the exact contribution of wage-earners can be measured. It has been demonstrated that this is difficult, if not impossible. The influence of individual productive capacity is felt on original rates granted members of a working force, but has greater influence on changes which are made in these rates after employment.

Payment of wages above the community level. Many plants have given up entirely the idea of determining exactly what the basic wage should be, and have fallen in with the thought that the greater the wages, within reasonable limits, which can be given to the employee, the more will be the inherent power provided in the organization. Although all industries are not in so favorable a position to pay high wages as the automotive industry has been, the lesson learned from this industry has been applied throughout the United States, and everywhere today there is less tendency to economize by reducing wage levels than there was just a few years ago.

That high wages do not necessarily mean high labor costs, but, properly utilized, may mean low labor costs, is well understood by the modern school of industrial managers. "High wages and low unit costs" was the central theme of Taylor's *Differential Piece Rate Plan.* Therefore, the determination of the economic basis of setting wages becomes less important as a manager attempts to set wages on a level which is higher than that paid corresponding workers in the community. The basis of most modern management steps involves the payment of higher wages than would be paid under the older types of management. This higher wage is returned through the lowering of overhead costs, due to increased production and other benefits that are secured by means of complete co-operation between the management and the workers. If this be the goal, together with the importance of wages as a factor in industrial management, the question of exactly how wage levels should be set decreases in importance.

The sliding scale. The sliding scale in wage payments involves arranging in advance reductions in rates when competitive conditions in the trade make these desirable and increases in rates that will enable workers to share with the employer the benefits of times of prosperity. Under this scheme a basic rate is fixed to correspond with a determined

selling price of some finished product of the industry, and then, with fluctuations of the selling prices, rates will drop or advance a predetermined amount. This method of wage payment finds little use in the United States, although it is used considerably more in Europe, particularly in England. It generally works to best advantage in negotiations between bodies of employers and unions, since it involves the acceptance of the plan on the part of employees; this is difficult to obtain except where they are organized. In certain regions of the British mining country the coal miners have had wide experience with sliding scales of wages based upon the selling price of coal. In 1921 the sliding scale of wages was tied not only to the selling price of coal but also to the average profit margin in the district.[5] Some careful students of the subject are of the opinion that such a program results in somewhat steadier employment.[6]

The method of determining the way the scale of pay shall fluctuate with the scale of selling prices is a matter for bargaining, but ordinarily the increase or decrease of the wage should bear approximately the same relationship to the increase or decrease of the selling price that wages bear to cost of production in the particular industry or plant.

A formal sliding scale, adopted in advance, will not succeed unless the commodity being manufactured has a wide, competitive market, with open quotations on current selling prices. Thus the sliding scale may easily be introduced into the manufacture of pig-iron because quotations on finished pig-iron are easily ascertainable. It may be introduced into cotton-spinning, because its fluctuations may readily be based on the selling price of a particular grade of cotton yarn. It is not applicable to a specialty business.

[5] See Z. Clark Dickinson, *Compensating Industrial Effort*, The Ronald Press, New York, 1937, pp. 345, 350.

[6] James A. Bowie, *Economic Journal*, Vol. 37 (Sept. 1927), pp. 384-393

CHAPTER XXIX

PRELIMINARY JOB-STUDY CONSIDERATIONS

The need for job studies. Lack of knowledge of what should constitute a job and how long it should take is one of the basic causes of labor disputes and industrial unrest. Since neither the employer nor the employee has any real information concerning these phases of the job, or concerning a single job in relation to other jobs, arbitrary standards which are widely divergent are frequently set up by both sides in order that they may be safe for each. An attempt of either side to enforce the basis that it has arbitrarily set up results in a dispute, which is usually settled by a compromise not predicated on facts, and satisfactory to neither party. Just as the lack of job standards is one of the most frequent fundamental causes of industrial disputes, plants which do have carefully set job standards are ordinarily those in which the fewest disputes occur and in which such disputes as do arise are settled most promptly and amicably. There is a basis of knowledge with which to settle them, and in these plants facts are used rather than opinions, prejudice, connivance, or force, which have been the more usual bases of settlement.

Fortunately from the social viewpoint, enlightened employers and labor leaders alike are coming to realize that justice to all concerned can best be attained through the use of facts. Labor leaders have asked for job studies and co-operated with managers in making these studies. This is a far cry from the period just before the World War (1914-1918) when Congress was induced to insert a rider to an appropriation bill forbidding the use of any of the appropriated money for "efficiency" studies.

The purposes of job study. The purposes of job study are two, the first of which may be utilized independently, without any thought of the second. These are to improve methods and conditions of work, and to develop a basis for the setting of rates. Methods are improved through a study of the operation and then, from the findings of the study, the equipment furnished workers is changed and the new methods are taught them.

Improving methods of work. Anyone at all familiar with industry knows that, on most jobs, different operators, if left to themselves, will do their tasks in entirely different lengths of time. Differences of 100 per cent in the time two operators take to do the same task are not at all unusual. It will usually be found, after study, that such operators are utilizing entirely different methods to perform the job. If the two

workers be analyzed, it will be found that one has discovered a number of short-cuts, while the other is performing a large number of useless or cumbersome motions. It is thus seen that the first step in job study is to determine the way in which the best worker performs the job, in order that some of his methods may be imparted to the poorer workers. The next step is to try to develop a standard method, which may be an improvement over the best method used up to that time, and which not only will improve all existing methods of working, but will include the utilization of all possible standard equipment for the job and will determine and, if possible, eliminate the causes of fatigue incident to the job. The third step in improving methods of work is to teach all the employees the new standardized method.

Motion study. Motion study is the simplest form of job study, and always forms the preliminary portion of a job study, even if a more elaborate study, such as motion and time study, is contemplated.

The simple motion study of a job in its general elements may reveal many losses and useless motions without any consideration of the time element. It is not necessary to hold a watch in one's hand to know that a worker who must walk a dozen feet to secure material for his machine or to deposit the finished product of his operation can have his work arranged more effectively. General motion study is likely to yield valuable information for the improvement of standards of equipment, and the elimination of useless motions is oftentimes one of the best ways of reducing fatigue. So all the aims of job study may be achieved without consideration of the time element, although if it is desired to refine these results, time study is usually utilized.

Interest in job study had been gradually increasing for a number of years, when certain experiments of Frank B. Gilbreth, in bricklaying methods, set forth in a small book called *Motion Study*,[1] focused interest on this subject. This was at about the time of the general increase in interest in the management movement, during 1911. Gilbreth's attention had been forcibly drawn to wasteful operation methods in this trade through his connection at that time with the contracting business. He had found, for instance, that bricks were dumped in a pile somewhere near the bricklayer by his unskilled assistant, and that the bricklayer would take two or three steps over to the pile of bricks, pick up a brick, walk back to the point in the wall where he was going to put it into position, give it several twirls, so that the right side for laying would be upward, and then proceed to put it into place. He also found that there were a large number of similar waste motions in connection with the placing of the mortar. From these observations he developed certain standard equipment, such as a packet

[1] D. Van Nostrand Co., New York.

for holding the bricks at a proper level and with the right side already up, and a non-stooping scaffold, which changed in height as the wall was built up. He then developed the best methods of utilizing this equipment, based on observation.

As the methods used by bricklayers on nearly every construction job are observed today, it will be quickly noticed that the studies of Gilbreth and others have not made the impression on this ancient art that might have been expected. This condition is sometimes due to the contractors, but in general it is caused by the attitude of the bricklaying unions to the studies of Gilbreth. As in the case of many other labor organizations, they have not always been favorable to the developments brought about by job studies, and they have been strong enough to resist successfully the introduction of much of the new method.

One of the next fields that was investigated, after Gilbreth directed attention to the wastes involved in ordinary bricklaying practice, was office work. In the handling of outgoing mail it was immediately seen that there were vast opportunities for economies in an improvement of the methods generally used in large offices. If several thousand letters are being mailed a day, as is the case in many industries, the saving of only one motion per letter mailed would result in an enormous net gain. For instance, in one office the girls folding and sealing the letters formerly were permitted to arrange the work to suit themselves. A short observation of their work showed that there was much room for improvement. Experiments were made to determine in just what order each movement should be made to fold the letter, pick up its inclosure, pick up the envelope, and insert the letter and its inclosure in the envelope. First attempts were crude, but immediately doubled the output of the girl. Further study resulted in improvements that not only eliminated motions, but shortened the distance through which the hands had to move in the motions that remained.

The field of motion studying office procedure is still a fertile one A great deal of work has been accomplished but there are many offices in large institutions that are relatively untouched. The T. V. A. inaugurated a cross-index filing system in 1933. During the following four years the output per day per typist typing the card index was increased from 72 pieces to 650 pieces, or an increase of 803 per cent. This improvement was not achieved by one study alone. In all, five different analyses were made, with percentage increases over the original production respectively as follows: 67-100-386-615-803.[2]

Effects of taking motion studies. There are several possible changes which come through the taking of motion studies. First, whole methods

[2] Minutes of Office Service Department Conference (T.V.A.) held Tuesday, October 12, 1937, Knoxville, Tennessee.

of performing operations may be changed and newer and more effective ones found. Second, moderate changes in method and in equipment may be devised. Third, data are always secured from which a series of job specifications may be developed. Fourth, motion study exerts a salutary influence upon the general morale of an organization when the savings made are shared with the employees.

Motion study and the development of standard equipment are inseparably linked. Frequently, soon after the start of a study, it becomes apparent that the worker can do no better with the equipment at hand, because he is forced by it through a series of false motions. Motion study may lead to such standardization of equipment on an operation that no further steps are needed in the instruction of workers in the performance of their jobs than instruction in proper use of this equipment. When the results of motion study are used for rate setting purposes, it is imperative that equipment be standardized within reasonable limits. To illustrate, if a rate is set from the study of an operator on one machine that is functioning properly, this same rate should not apply on another machine exactly the same in every detail save the fact that it has 5 per cent more belt slippage. In changing the methods used on the operation, changes should always be made in the direction of straighter, shorter, quicker motions of a kind which become automatic wherever possible.

Meaning of time study. By time study is meant an accurate analysis of time necessary to perform an operation or some part thereof. It involves all the features of close observation that are found in motion study, and in addition there is included the time element. In modern industry, for purposes of job study all work may be placed under two general headings: (1) work done by machines and (2) work done by workmen. Motion study concerns itself, especially, with a study of the work done by the workman with sufficient consideration of the arrangement of machines and their functioning to insure efficient worker production, whereas time study includes a detailed analysis of both "machine time," or the time taken by the machine in doing its share of the work, and "handling time," or the time taken by the workman. Handling time will usually be found to be of three general classes: (1) the handling of tools used by the workman in connection with the job, (2) the handling of the machine by the workman, and (3) the handling of the material that is being worked upon. Time study implies an intense analysis of all these phases of work.

Purposes of taking time studies. The purposes of making such an intense analysis of work are in some respects similar to the reasons behind the making of any job study. *Improvement of methods and conditions* are at times the only reasons for the making of time studies.

Indeed, motion studies are frequently the first step in the taking of time studies, but pure motion studies are not so frequently used as time studies, since with only a slight additional cost valuable data securable through time studies may be made available. The addition of the time element to the study makes it possible to secure information concerning the amount of work which may be accomplished within a given time. Time study data give an adequate basis for establishing the remuneration to be given a worker for his performance. Thus, the results of time studies are used as the *basis of "rate-setting,"* or the determination of wage rates. This is the second broad purpose for which time studies are used and the one which will be in the background of most of what is here said concerning time studies. However, time studies should not be used for rate-setting without being used at the same time to improve methods or conditions.

Time study provides data which are invaluable in setting rates that are relatively fair as compared one to another. Time study cannot be expected to set rates that are inherently fair from a cost-of-living or similar standard. That is beyond its province. It does clearly indicate fair relative rates to be paid on the several jobs studied. It bases results upon comparative facts rather than upon opinions, bargains, or past records.

Rates, if not based on time studies, are likely to be based on past performances. Standard time and hence rates based on past performances, are likely to be unfair. In all factories are to be found poor workmen and good workmen. A good workman on job A takes an interest in his work and in the mastering of his job. A poor workman on job B is probably indifferent to his work, or it may be that he has never been properly instructed as to the right way of working on the job. If the records of poor workmen and good workmen are thrown together, throughout a shop, as "past performance," the resulting basis of rate-setting is likely to be unfair. The poor workman, by learning his job or merely by applying himself, may be able under such conditions to double his pay, whereas the good workman, if the job is one where he has always set a high standard, will get but a slight wage increase, if any. Other difficulties in setting rates on the basis of past performance are due to the fact that past records are frequently extremely unreliable. Jobs of the past were frequently made up of different elements than jobs of the present. Conditions under which jobs were performed have often been modified by forgotten changes in equipment which are not taken into consideration as the new rate is set. Frequently, since the past records are unreliable, it is necessary to resort to bargaining concerning what past performance was. Nothing can be more destructive of the wage fabric of any plant than bargaining over opinions when factual data ought to be available.

Steps in taking time studies. To secure accurate knowledge of the time necessary to perform a certain job is by no means in itself a simple task, and the taking of the time is but one portion of the whole task of taking a time study. Time studies, to be of maximum value, must be "elementary time studies." That is, the time should be taken not for the job as a whole, but for the various elements of the job, and then the correct time for the complete job determined after making an analysis of the times necessary to do the various elements. In the job of operating any machine there will be found a long series of elements, ranging from those involved in starting the machine and placing material in it, through those involved in turning certain controls during the operation of the machine to those involved in removing the work from the machine. The taking of the times, when the job is split into such a large number of small elements, is a rather skilled task.

In taking time studies there is entailed (after standardization work has been completed) the following steps:

1. A careful survey of the task to be completed, with a view to improvements. (These improvements should be made before proceeding with the second step.)
2. The division of the task into its elements.
3. The observing and recording of the time consumed in performing each element of the task.
4. A study or analysis of the recorded times.
5. The determination of the proper operation time based upon all the facts observed in the analysis of the recorded times.

The fourth and fifth steps involve considerable study, in determining the correct way to utilize the information which has been collected. In recording times for elementary operations it is usually found that there have been some abnormal readings, and these must be eliminated and allowances must be made for delays that may have occurred, or may occur in the future, and these delays must be considered in the light of their being avoidable or unavoidable. There must usually also be some allowance made for fatigue on the part of the operator and also for personal needs. Frequently, on the basis of the data, the whole job is rearranged and restudied.

The job-study observer. The first requisite in job study is that the observer be competent. This is so outstandingly true that it would be ridiculous to mention, were it not that incompetent managers frequently use incompetent time-study observers, and otherwise competent managers have frequently seemed to feel that anyone equipped with a stop-watch could secure the necessary information. It is for this probably more than any other reason that job study fell into disrepute among many

portions of the industrial community prior to the World War. The observer must be of an analytical turn of mind, able to detect small variations in the process from time to time. He must, however, have enough knowledge of the machine and process to be able to perceive and try out slight mechanical changes which may be called to his attention during his studies.

Besides these technical qualifications, a job-study observer must be able to win the confidence of the men with whom he is working. This means he must himself have confidence in the workers and gain their confidence, as well as gain the confidence of the superintendent and the foremen. In devising a standard method to perform a job, many possibilities will have to be investigated, and the worker's co-operation is essential, particularly if he has a fund of knowledge based on past experience with the job.

There is no intention to minimize the necessity of technical qualifications of time-study observers, because the more the observer knows of the operation, the better able he will be to suggest alternative methods. On the other hand, if he has gained the confidence of the whole department in which he is working, he has performed a large portion of his task.

Confidence is necessary for several reasons: (1) As in any management step, full co-operation of everyone is needed for the best results. (2) Secrecy is impossible even should it otherwise be desirable. The workmen will hear rumors, which will be worse than the facts, whatever they may be, and these rumors will be confirmed when their rates are changed based on the observations that they knew of only by rumor. (3) In order that the time study may be of maximum value, it is necessary that shop information which has been collected by the foreman and workmen over a period of years shall be at the disposal of the time-study men.

The operator to be studied. Time-study men generally incline to the belief that it is the skilled, first-class worker who should be studied. This means that the worker will be of better than average ability, and will be as good on quality as he is on quantity. This does not mean that the study will be made on a man who is working at a terrific rate of speed, for such a man is probably turning out no more production than the man who, more skilled, is taking things easier.

The skilled man is selected, rather than the average man, because allowances will be made in the computation of times which will be fair to the average man, and the skilled man is better for observation purposes. His motions are uniform, he works steadily, he is apt to use the best methods and adapt himself more readily to new ones. The erratic work of unskilled employees would throw all sorts of variables into the calculations which would merely have to be ruled out as the

computations were made. The experienced time-study observer, acquainted with the character of the work, soon learns when a skilled operator is doing his best. He would have more difficulty in finding this out in the case of an unskilled operator. The observer, with the skilled man, is able to get him to better his production if need be, or, on the other hand, to recognize unusual ability or excessively rapid movements on the part of the operator which could not be maintained without physical exhaustion. Such cases are properly discounted by the observer, for the desired time standard is one that can be used by workers following instructions and working at a reasonable pace—a pace that can be kept up from day to day without undue exertion. Another reason for the selection of the skilled man is that in setting performance standards, as in setting any other standard, the best known method at the time for the given conditions should be selected as the standard.

On work in which large numbers of workers are engaged, and which is to last for some time, more than one operator should be time-studied in order that the resultant rates may represent standard performance without question.

The conditions of the observation will have to be varied somewhat in the case of "group work," that is, work in which the individual job is performed by more than one employee. In such work as assembling, the speed of the group is limited largely by the speed of the slowest member. Therefore, in such cases, it will be necessary to consider carefully the personnel of the group to see whether or not it is composed entirely of skilled employees, and, if not, whether such a group can be brought together. Attention should also be given to the operations assigned each member of the group working on the assembly. It is sometimes found that an employee who is thought to be slow and thus holding back his group is in fact doing more work than is justly his share. A rearrangement of his tasks may shift a part of his work to another and thus increase the efficiency of his group. In case the individual operator is slower than his group, he should be transferred if possible. In case he is kept in the group for some reason, an adjustment of tasks may still result in greater efficiency. When others are carrying a part of the work for a given operator earnings should be adjusted accordingly. There are two classes of group work, and the necessary skill of all members of the group will vary with the class into which the particular work falls. These classes are: (1) where the main part of the operation is performed by one employee, and he is merely assisted by other employees, and (2) where several employees work together, each doing his portion of the job in proper sequence.

An illustration of the first type of group work is to be found in the operation of laying cloth in a clothing factory. Although the operation

is comparatively simple, to handle each type properly demands a certain knowledge of the tailoring trade and the peculiarities of cloth. A cloth which has a very smooth finish may be easily disarranged in pulling one layer over the next, while another which has a heavy nap may tend to stick and must be handled in an entirely different manner. One employee cannot do the work alone because of the width of the cloth, which requires that he have an assistant working on the opposite side of the table. The assistant, of course, must learn how to handle the cloth, but he does not need so much detailed knowledge, and hence will not need to be as skilled an employee as the one in charge of the operation. As an example of the second type of group operation may be taken any case of continuous assembly, where the speed of one worker is limited by the speed of another, and yet all are doing work of approximately equal importance.

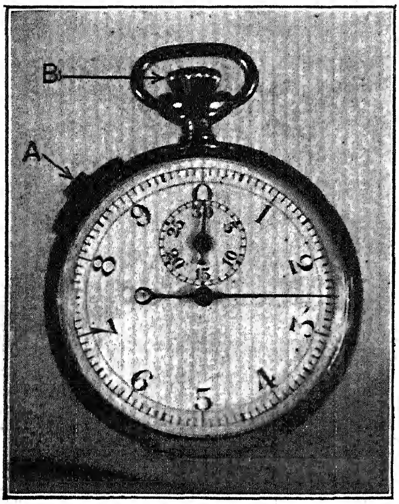
Dangers to be guarded against in taking job studies. Though the possibilities for good of job study, properly used, are almost unlimited, when incorrectly used its possibilities for evil are also unlimited. One danger to be guarded against is an approach to a workman based on superiority rather than on science. A second danger to be guarded against is the taking of time studies when the conditions are not standard. Not only will all the work done be useless under such conditions, but the studies themselves will fall into disrepute. This is true particularly if the workmen know of the loopholes in the standards being set at the time the studies are taken. Time spent on the development of preliminary standards of material and equipment will pay profits much more promptly than twice as much time spent on standard times for unstandardized jobs. This "standard" time will be worthless, being based on variables. A third danger is to spend time in making "stunt" time studies. There is always a tendency to spend effort in reducing the time of performance on operations which evidently are poorly carried on. In such cases statistics of percentages of time reduction will be interesting, but if the operation be an unimportant one, as it is likely to be if such huge reductions in performance time are possible, the profit from the study will be small. A series of such studies may cost more than the resultant profits, and a whole job-study program thus fall into disrepute. The neck-of-the-bottle operations, the most important in any plant, should be studied first.[3] Even small results achieved there will unquestionably bring large profits with them. It may take longer to get results, but if the continuation of a job-study program is based on quick results, the program should never be undertaken.

[3] See Harold B. Maynard and G. J. Stegemerten, *Operation Analysis*, McGraw-Hill Book Company, Inc., New York, 1939, pp. 31–34.

CHAPTER XXX

TAKING TIME STUDIES

Time-study equipment. The equipment for taking time studies is essentially simple, though some improvements which are now being tried out will be described. The ordinary equipment consists of a decimal stop-watch, an observation sheet on which the watch readings are recorded as the study progresses, and a board for holding the watch and observation sheet. Many different forms of observation sheets have been devised. The attached sheet (Fig. 125a), used by the L. C. Smith and Corona Typewriters, Inc., of Groton, N. Y., will be used as the basis for this discussion of making time studies. It is selected because of its completeness and the care which that company observes in making and utilizing job studies. In any event, the observation sheet must have space for a full description of the operation and conditions under which it was taken, with the conditions illustrated, if practicable; space for entering the times of the various elements as they are observed; and a series of columns concerning the time of each element and the proper time for the whole operation.



Courtesy Ralph M. Barnes, "Motion and Time Study."

Fig. 124. Stop Watch.

The usual stop-watch used in time-study work is a non-continuous-movement watch; that is, the movement of the watch runs only when the large hand is in motion. The large hand may be started and stopped by pressing a slide on the side. (See A, Fig. 124.) This arrangement allows the watch to be started and stopped at will, without throwing the hand back to zero. Pressure on the top of the stem (B, Fig. 124) throws the hand back to zero so that the observer can commence the record of a new cycle at zero if he should so desire. The dial of the watch is marked off into tenths and hundredths of a minute, instead of seconds

TIME STUDY OBSERVATION SHEET

THE L. C. SMITH AND CORONA TYPEWRITERS INC.

PART No. 2X92 OPERATION No. 4 OPERATION NAME DRILL ALL HOLES

OPERATORS No. 328 OPERATORS NAME H. T. FLYNN.

OPERATION PERFORMED IN DEP'T No. 3 UNIT TIMED ONE JIG FULL, OF ONE PIECE.

OBSERVERS OPINION OF OPERATOR:—
EXPERIENCE 5 MONTHS THIS JOB -3 YRS. DRILLING.
SKILL HIGH GRADE AND RAPID.
CO-OPERATION WITH OBSERVER EXCELLENT.

PURPOSE OF THIS STUDY:—
FOR SETTING STANDARD TIME AND RATE YES.
FOR PRELIMINARY SURVEY FOR BETTERING CONDITIONS —
FOR TEST OF OPERATORS PRODUCING ABILITY —

UNIT TIMES RECORDED IN MINUTES AND HUNDREDTHS

Sub-Operation Number	Sub-Operation		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
1	PICK UP, LOCATE AND LOCK.	R	.11	.12	.10	.10	.11	.11	.12	.10	.10	.10	.10	.11	.09	.11	.10	.12	.11	.11	.11	.10	.10	.10	.11	.09	.10
		T	.11	.12	.10	.10	.11	.11	.12	.10	.10	.10	.10	.11	.09	.11	.10	.12	.11	.11	.11	.10	.10	.10	.11	.09	.10
2	DRILL THREE #40 HOLES.	R	.44	.47	.46	.40	.44	.44	.47	.42	.45	.45	.44	.44	.45	.44	.42	.40	.44	.45	.44	.42	.43	.46	.44	.42	.41
		T	.33	.35	.36	.30	[illegible]	.33	.35	.32	.33	.35	.34	.33	.36	.33	.32	.32	.33	.34	.33	.32	.33	.36	.33	.33	.31
3	DRILL FIVE #48 HOLES.	R	.96	1.01	.99	.94	.99	.96	.98	.94	.95	.99	.98	.98	.98	.96	.95	.93	.97	.98	.95	.94	.95	.97	.96	.95	.93
		T	.52	.54	.53	.54	.55	.52	.51	.52	.52	.54	.54	.54	.53	.52	.53	.53	.53	.53	.51	.52	.52	.51	.52	.53	.52
4	DRILL TWO #9 HOLES.	R	1.11	1.15	1.15	1.09	1.13	1.10	1.14	1.10	1.11	1.15	1.15	1.14	1.15	1.12	1.11	1.00	1.14	1.15	1.13	1.11	1.11	1.13	1.11	1.10	1.07
		T	.15	.14	[illegible]	.15	.14	.14	.16	.16	.16	.16	.17	.16	.17	.16	.14	.17	.17	.17	.18	.17	.16	.16	.15	.15	.14
5	UNLOCK AND REMOVE.	R	1.16	1.21	1.21	1.16	1.18	1.16	1.20	1.15	1.19	1.21	1.21	1.21	1.22	1.17	1.19	1.06	1.19	1.20	1.18	1.17	1.16	1.19	1.18	1.17	1.13
		T	.05	.06	.06	.07	.05	.06	.06	.05	.08	.07	.06	.07	.07	.07	.08	.06	.05	.05	.05	.06	.05	.06	.07	.07	.06
6	CLEAN JIG.	R	1.23	1.26	1.29	[illegible]	1.25	1.24	1.28	1.28	1.26	1.28	1.28	1.29	1.28	1.26	1.27	1.14	1.26	1.27	1.25	1.25	1.23	1.26	1.25	1.25	1.19
		T	.07	.07	.08	.07	.07	.08	.08	.08	.07	.07	.07	.08	.06	.07	.08	.08	.07	.07	.07	.08	.07	.07	.07	.08	.06
	(CONTINUED)																										
1	PICK UP, LOCATE AND LOCK.	R	.10	.10	.11	.11	.11	.12	.10	.11	.09	.11	.10	.10	.10	.10	.12	.11	.11	.10	.10	.12	.11	.09	.10	.11	.10
		T	.10	.10	.11	.11	.11	.12	.10	.11	.09	.11	.10	.10	.10	.10	.12	.11	.11	.10	.10	.12	.11	.09	.10	.11	.10
2	DRILL THREE #40 HOLES.	R	.43	.42	.44	.45	.44	.40	.42	.44	.45	.44	.44	.45	.43	.42	.47	.44	.44	.40	.46	.47	.44	.44	.41	.41	.40
		T	.33	.32	.33	.34	.33	.32	.32	.33	.36	.33	.34	.35	.33	.32	.35	.33	.33	.30	.36	.35	.33	.35	.31	.30	.30
3	DRILL FIVE #48 HOLES.	R	.96	.95	.97	.99	.99	.92	.93	.98	.99	.98	.97	.97	.95	.94	1.00	.97	.98	.94	.99	1.00	.96	.95	.93	.94	.92
		T	.53	.53	.53	.54	.55	.52	.51	.54	.54	.54	.53	.52	.52	.52	.53	.53	.54	.54	.53	.53	.52	.51	.52	[illegible]	.52
4	DRILL TWO #9 HOLES.	R	1.10	1.10	1.11	1.15	1.14	1.06	1.07	1.14	1.15	1.14	1.13	1.14	1.11	1.11	1.16	1.13	1.15	1.11	1.16	1.18	1.13	1.11	1.08	1.09	1.06
		T	.14	.15	.14	.16	.15	.14	.14	.16	.16	.16	.16	.17	.16	.17	.16	.16	.17	.17	.17	.18	.17	.14	.15	.15	.14
5	UNLOCK AND REMOVE.	R	1.15	1.16	1.17	1.22	1.19	1.12	1.13	1.19	1.23	1.20	1.19	1.21	1.18	1.18	1.24	1.19	1.20	1.16	1.21	1.24	1.18	1.16	1.14	1.15	1.13
		T	.05	.06	.06	.07	.05	.06	.06	.05	.08	.06	.06	.07	.07	.07	.08	.06	.05	.05	.05	.06	.05	.05	.06	.06	.07
6	CLEAN JIG.	R	1.20	1.22	1.24	1.29	1.27	1.20	1.22	1.26	1.29	1.27	1.25	1.29	1.26	1.26	1.31	1.26	1.27	1.23	1.29	1.31	1.25	1.23	1.21	1.23	1.19
		T	.05	.06	.07	.07	.08	.08	.09	.07	.06	.07	.06	.08	.08	.08	.07	.07	.07	.07	.08	.07	.07	.07	[illegible]	.08	.06
	DELAY FACTORS.																										
A	CHANGE DRILLS.	R	.50	.55	.43	.58	.62	.46	(2) .72	.52	.55	.60	.47														
		T	6.00 Min																								
B	CLEAN MACHINE TABLE.	R	.11	.13	.21	.10	.18	.11	.14	.12	.18	.22	.15	.11	.10	.14											
		T	2.00 Min																								
C	ADJUST FLOW OF LUBRICANT.	R	.14	.26	.10																						
		T	.50 Min.																								
D	CHANGE PANS OF WORK.	T	None occurred during this study.																								

Sub-Operation Number	Sub-Operation		26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	Average Time	Minimum Time	Time Should Take
1	PICK UP, LOCATE AND LOCK.	R	.11	.11	.12	.09	.09	.10	.09	.09	.10	.08	.09	.10	.10	.10	.11	.10	.11	.09	.09	.10	.11	.10	.11	.10	.09			
		T	.11	.11	.12	.09	.09	.10	.09	.09	.10	[illegible]	.09	.10	.10	.10	.11	.10	.11	.09	.09	.10	.11	.10	.11	.10	.09			
2	DRILL THREE #40 HOLES.	R	.44	.42	.40	.46	.45	.46	.44	.46	.43	.47	.46	.46	.44	.44	.44	.45	.44	.46	.46	.45	.42	.40	.41	.41	.44			
		T	.33	.31	.32	.37	.30	.36	.35	.37	.33	.39	.37	.36	.34	.34	.33	.35	.33	.37	.37	.35	.31	.30	.30	.31	.35			
3	DRILL FIVE #48 HOLES.	R	.96	.96	.95	.99	.98	1.01	.98	1.00	.98	1.01	.99	.98	.95	.96	.97	.97	.96	1.00	1.01	.98	.95	.95	.95	.95	.99			
		T	[illegible]	.54	.55	.53	.53	.55	.54	.54	.55	.54	.53	[illegible]	.51	.52	.53	.52	.52	.51	.55	.53	[illegible]	.55	.54	.54	.55			
4	DRILL TWO #9 HOLES.	R	1.11	1.10	1.11	1.14	1.12	1.15	1.14	1.16	1.14	1.17	1.16	1.14	1.12	1.12	1.13	1.14	1.13	1.17	1.19	1.15	1.11	1.11	1.11	1.10	1.14			
		T	.15	.14	.16	.15	.14	.15	.16	.16	.16	.16	.17	.16	.17	.16	.16	.17	.17	.17	.18	.17	.16	.16	.16	.15	.15			
5	UNLOCK AND REMOVE.	R	1.17	1.16	1.16	1.20	1.18	1.21	1.20	1.23	1.21	1.23	1.22	1.20	1.17	1.15	1.20	1.21	1.19	1.25	1.26	1.22	1.17	1.17	1.18	1.16	1.20			
		T	.06	.06	.05	.06	.06	.06	.06	.07	.07	.06	.06	.06	.05	.06	.07	.07	.06	.08	.07	.07	.06	.06	.07	.06	.06			
6	CLEAN JIG.	R	1.24	1.23	1.24	1.27	1.25	1.29	1.28	1.30	1.29	1.31	1.30	1.27	1.25	1.26	1.27	1.27	1.25	1.32	1.32	1.29	1.24	1.24	1.25	1.24	1.27			
		T	.07	.07	.08	.07	.07	.08	.08	.07	.08	.08	.08	.07	.08	.08	.07	.06	.06	.07	.06	.07	.07	.07	.07	.08	.07			
	(CONTINUED)																													
1	PICK UP, LOCATE AND LOCK.	R	.11	.09	.09	.11	.10	.11	.10	.10	.10	.09	.08	.10	.09	.09	.10	.09	.09	.12	.11	.11	.10	.09	.10	.11	.10			
		T	.11	.09	.09	.11	.10	.11	.10	.10	.10	.09	.08	.10	.09	.09	.10	.07	.09	.12	.11	.11	.10	.09	.10	.11	.10	.1022	.08	.10
2	DRILL THREE #40 HOLES.	R	.42	.46	.46	.44	.45	.44	.44	.44	.46	.46	.47	.43	.46	.46	.46	.45	.46	.40	.42	.44	.41	.42	.45	.44	.46			
		T	.31	.37	.37	.33	.35	.33	.34	.34	.36	.37	.39	.33	.37	.37	.36	.36	.37	.32	.31	.33	.31	.33	.35	.33	.30	.3382	.30	.33
3	DRILL FIVE #48 HOLES.	R	.94	1.00	1.01	.97	.98	.99	.98	.98	1.00	1.00	1.00	.97	.97	.98	.99	.97	.98	.94	.97	.97	.94	.97	.99	.98	1.00			
		T	.52	.54	.54	.53	.53	.55	.54	.54	.54	.54	.53	.54	.51	.52	.53	.52	.52	.54	.55	.53	.53	.55	.54	.54	.54	.5312	.51	.53
4	DRILL TWO #9 HOLES.	R	1.09	1.14	1.17	1.12	1.12	1.13	1.14	1.14	1.16	1.16	1.17	1.13	1.14	1.14	1.15	1.14	1.15	1.11	1.15	1.14	1.10	1.13	1.15	1.13	1.15			
		T	.15	.14	.16	.15	.14	.14	.16	.16	.16	.16	.16	.16	.17	.16	.16	.17	.17	.17	.18	.17	.16	.16	.16	.15	.15	.1582	.14	.16
5	UNLOCK AND REMOVE.	R	1.14	1.20	1.23	1.17	1.20	1.19	1.20	1.21	1.23	1.23	1.25	1.19	1.19	1.19	1.20	1.20	1.20	1.16	1.23	1.21	1.17	1.19	1.21	1.20	1.21			
		T	.05	.06	.06	.05	.08	.06	.06	.07	.07	.07	.08	.06	.05	.05	.05	.06	.05	.05	.08	.07	.07	.06	.06	.07	.06	.062	.05	.06
6	CLEAN JIG.	R	1.20	1.27	1.29	1.25	1.29	1.29	1.28	1.29	1.32	1.30	1.32	1.26	1.27	1.27	1.28	1.27	1.29	1.24	1.30	1.29	1.24	1.26	1.27	1.26	1.29			
		T	.06	.07	.06	.08	.09	.10	.08	.08	.09	.07	.07	.07	.08	.08	.08	.07	.09	.08	.07	.08	.07	.07	.06	.06	.08	.073	.05	.07

This time excessive should be done while drilling

This is approximately 7% of the total time taken during study

TOTAL AVERAGE 1.2648 1.13 1.25

H. V. Williams
OBSERVER

DATE

NOTE—When possible record time for each sub-operation by continuous reading of watch, resetting to zero only at completion of each unit. Record elapsed time expended in each sub-operation in red ink. Observer must exercise extreme care in making studies for Production Tests or Standard Time and Rate setting purposes, to see that proper sequence of operations is maintained; that all unnecessary sub-operations or moves are eliminated; that proper appliances are provided, (including tools, in sufficient quantities) and that the proper and most economical combinations of speed and feed are used. In right hand column above, observer will give his opinion of the time that should be taken for each sub-operation by a fast and thoroughly experienced man, moving at his best normal speed. Observer will record a sufficient number of times to give a clear idea of the time required by the operator, for each sub-operation.

FIG. 125a.

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DETAIL RECORD OF METHOD OF OPERATION

146-7024-5m-11-20

SUB OPERATION NUMBER	FULL DESCRIPTION OF EACH SUB-OPERATION	MACHINE SPEED R. P. M.	MACHINE FEED P. M.	TOOLS USED IN EACH SUB-OPERATION TOOL NUMBER	TOOL — NAME
	OPERATOR WORKS SITTING DOWN.				
1	PICK UP ONE UNFINISHED PIECE FROM PAN ON TABLE, WITH LEFT HAND, PLACE IN JIG AND LOCK JIG.			590) 1125) 2347)	JIG
2	SLIDE JIG UNDER FIRST SPINDLE, DRILL TWO #40 HOLES IN TOP EDGE. TURN JIG ¼ OVER, DRILL ONE #40 HOLE THROUGH SIDE.	2040	HD.	#40	DRILL
3	SLIDE JIG UNDER SECOND SPINDLE, DRILL TWO #48 HOLES THROUGH SIDE. TURN JIG ¼ OVER, DRILL TWO #48 HOLES IN TOP EDGE. TURN JIG ½ OVER, DRILL ONE #48 HOLE IN BOTTOM EDGE	2040	HD.	#48	DRILL
4	TURN JIG ¼ OVER, SLIDE UNDER THIRD SPINDLE, DRILL TWO #9 HOLES.	2040	HD.	#9	DRILL
5	TURN JIG ¼ OVER, UNLOCK JIG, REMOVE FINISHED PIECE AND THROW IN PAN FOR FINISHED WORK ON TABLE.				
6	BLOW ALL CHIPS FROM JIG WITH COMPRESSED AIR.			AIR	VALVE

(NOTE - ALL SPINDLES ARE OPERATED WITH HAND LEVERS. KEEP A HEAVY FLOW OF LUBRICANT ON DRILLS. KEEP MACHINE TABLE FREE FROM CHIPS, SO JIG WILL SET SQUARELY. TEST DEPTH AND DIAMETER OF TWO HOLES AFTER EACH CHANGE OF #40 OR #48 DRILL.)

NOTE — Observer will be careful to give an exact record of all movements necessary to properly complete this piece. In operations where maintenance of an exact feed or speed is not of importance specify the allowable maximum and minimum limits.

STUDY TAKEN ON MACHINE-NAME 3 SPINDLE, STYLE E, LELAND GIFFORD CO. DRILL PRESS. MACHINE NO. 040306

EQUIVALENT MACHINES ON WHICH JOB CAN BE RUN UNDER SIMILIAR CONDITIONS—NO. 040301-2-3-4-5, 040401-2-3-4.

EMERGENCY MACHINES ON WHICH JOB CAN BE RUN ANY OTHER DRILL PRESS. (INCONVENIENT AND NOT DESIRABLE)

LOCATION OF UNFINISHED WORK IN PAN ON TABLE, LEFT OF OP.

LOCATION OF FINISHED WORK IN PAN ON TABLE, RIGHT OF OP.

LOCATION OF FIXTURE OR SPECIAL DEVICES JIG ON MACHINE TABLE, FREE AND MOVABLE.

ALL TOOLS AND EQUIPMENT REQUIRED (GIVE TOOL NUMBERS)
JIG 1125-2347-590.
DRILLS, #9 HIGH SPEED
" 40 CARBON
" 48 "
CHAIR FOR OPERATOR
AIR CONNECTIONS

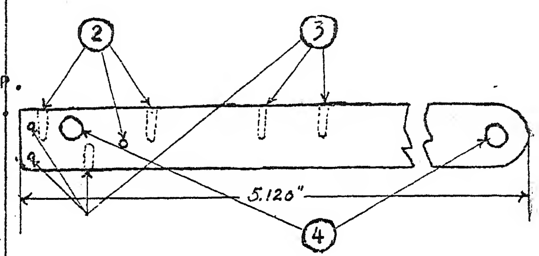
GAUGES REQUIRED (GIVE TOOL NUMBER)
(GIVEN BELOW UNDER REMARKS)

MATERIAL-KIND COLD DRAWN STEEL.

THICKNESS .162" WIDTH .502" GRADE "SPECIAL"

SKETCH OF PIECE AND OPERATION PERFORMED

WHEN POSSIBLE SHOW A LIGHT OUTLINE OF THE PIECE WITH A HEAVY OUTLINE OR PLAIN INDICATION OF THE OPERATIONS PERFORMED AND FINISHED CONDITION. GIVE DIMENSIONS OF CUTS WHEN NECESSARY FOR A CLEAR DESCRIPTION OF ACTUAL WORK PERFORMED.



SUB-OP. 2 DRILL AS SHOWN AT 2
" 3 " " " " 3
" 4 " " " " 4

#40 HOLES IN EDGES .275" DEEP.
#48 " " " .180" "

NUMBER OF MACHINES RUN BY OPERATOR ONE LUBRICANT USED WATER COMPOUND HOW USED PUMP-HEAVY FLOW

#1 SPINDLE SPEED 2040 R. P. M. FEED HAND P. M. CONDITION IN WHICH WORK WILL COME TO JOB FAIRLY CLEAN AND FREE FROM CHIPS, AND AS LEFT BY PREVIOUS OPERATION.
#2 " " " " "
#3 " " " " "

ALLOWANCES RECOMMENDED		PER 9½ HRS.	PER HR.	PER CENT
PERSONAL	-	17.1 M	1.8 M	3
FATIGUE	-	11.4 M	1.2 M	2
MCH. DELAY	-	57.0 M	6.0 M	10

REMARKS GAUGE #543, 1637, 1638, 1571, 1227, 1639, 2025, 2026, 2027, 2028-USE ANY ONE
GAUGE #1653, 1654, 1655, 1656 - USE ANY ONE. GAUGE ST393.
GAUGE #1658, 1659 -- USE EITHER. GAUGE ST233.
GAUGE #1640, 1657 - USE EITHER. GAUGE 2520.
GAUGE FOR SETTING DRILLS TO DEPTH #2383, 2384, 2385, 2386 - USE ANY ONE.

SUGGESTIONS FOR BETTERMENT OF EITHER METHOD OF OPERATION OR TOOLS AND EQUIPMENT USED IN THIS STUDY JIGS TIGHTEN BY A THUMB SCREW - WOULD WORK QUICKER AND EASIER IF CHANGED TO A CAM LEVER DEVICE. (CHANGE LATER - NOT ADVISABLE NOW). ATTACH PLATE TO SIDE OF JIG TO ACT AS GAUGE FOR SETTING DRILLS TO DEPTH. (CHANGE LATER - WILL SPEED UP CHANGING OF DRILLS). MAKE COMBINED WOODEN BOX AND DRILL BLOCK, WITH HOLES IN BLOCK FOR SHARP AND DULL DRILLS - BOX TO HOLD JIG, AND BLOCK TO HOLD DRILLS-THIS FOR CONVENIENCE IN DELIVERING TO JOB, AND AVOIDING OPERATOR MIXING SHARP AND DULL DRILLS ON JOB.

SPECIAL INSTRUCTIONS FOR MACHINE ADJUSTERS, SET UP MEN AND SUPERVISORS TO COMPLETE PIECE AS PER THIS METHOD SUPERVISOR OR SET UP MAN WILL SEE THAT ALL TOOLS, GAUGES, PANS FOR FINISHED WORK, SUPPLY OF LUBRICANT AND OF UNFINISHED WORK ARE ON HAND: THAT SET UP IS CORRECTLY MADE AND WILL TURN OUT THE CORRECT STANDARD OF QUALITY, BEFORE AN OPERATOR IS ASSIGNED TO THE JOB.

INSPECTION NECESSARY TO COMPLETE PIECE AS PER THIS METHOD—BY INSPECTION SEE THAT ALL HOLES ARE DRILLED AND HOLES ARE CENTRAL IN STOCK. GAUGE LOCATION OF FULCRUM HOLE G 543, ETC. ABOVE. GAUGE DIA. OF FULCRUM HOLE G 1653, ETC. ABOVE. GAUGE LOCATION OF #40 DRILL HOLE G 2520. GAUGE DIAMETERS OF #40 DRILL HOLE G ST393: #48 DRILL HOLE G ST233: GAUGE DEPTH
BY OPERATOR OF #40 DRILL HOLE G 1658 OR 1659: DEPTH OF #48 DRILL HOLE G 1640 OR 1657.

FIG. 125b.

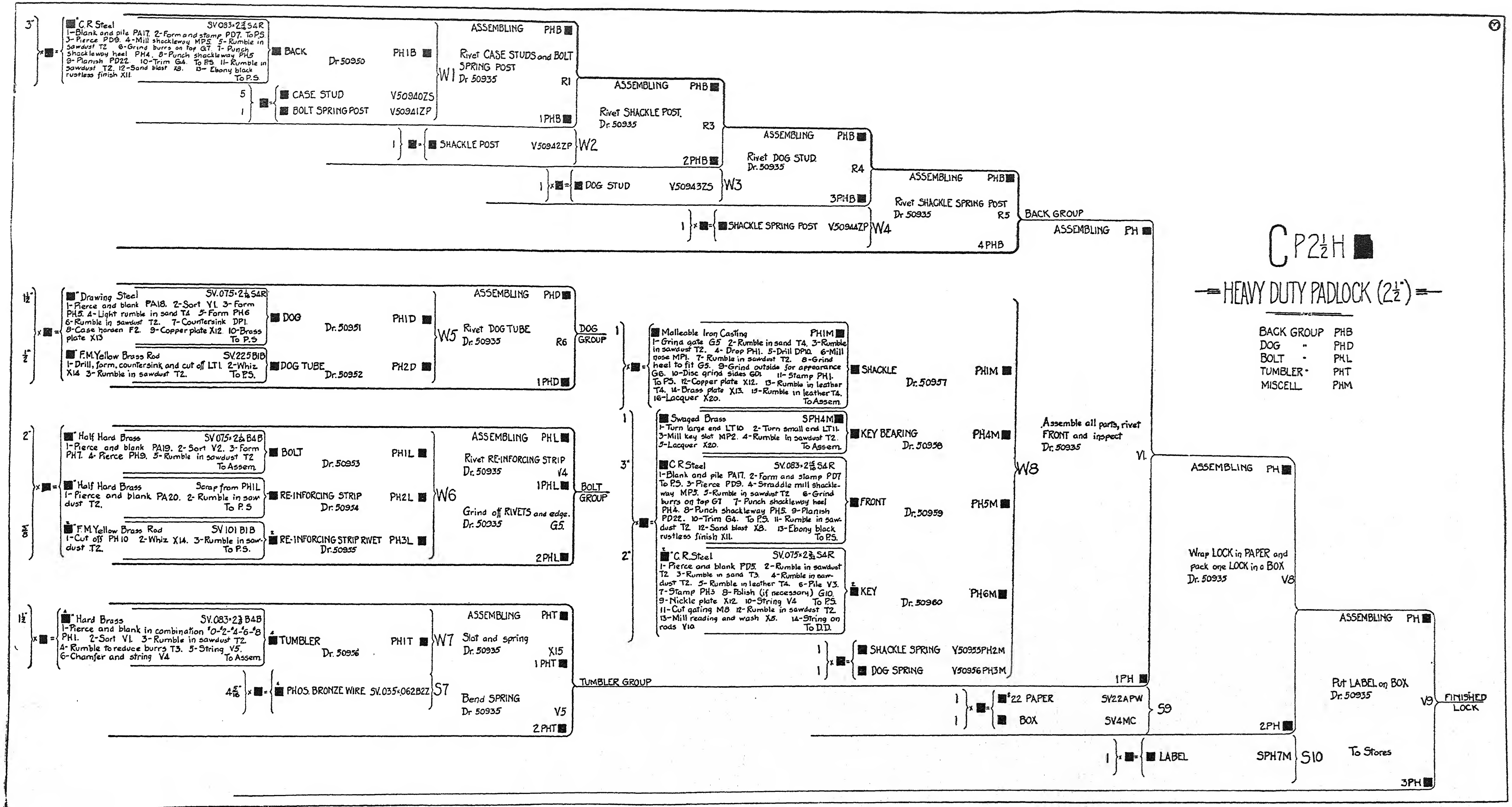


FIG. 155. A Route Chart for a Padlock.

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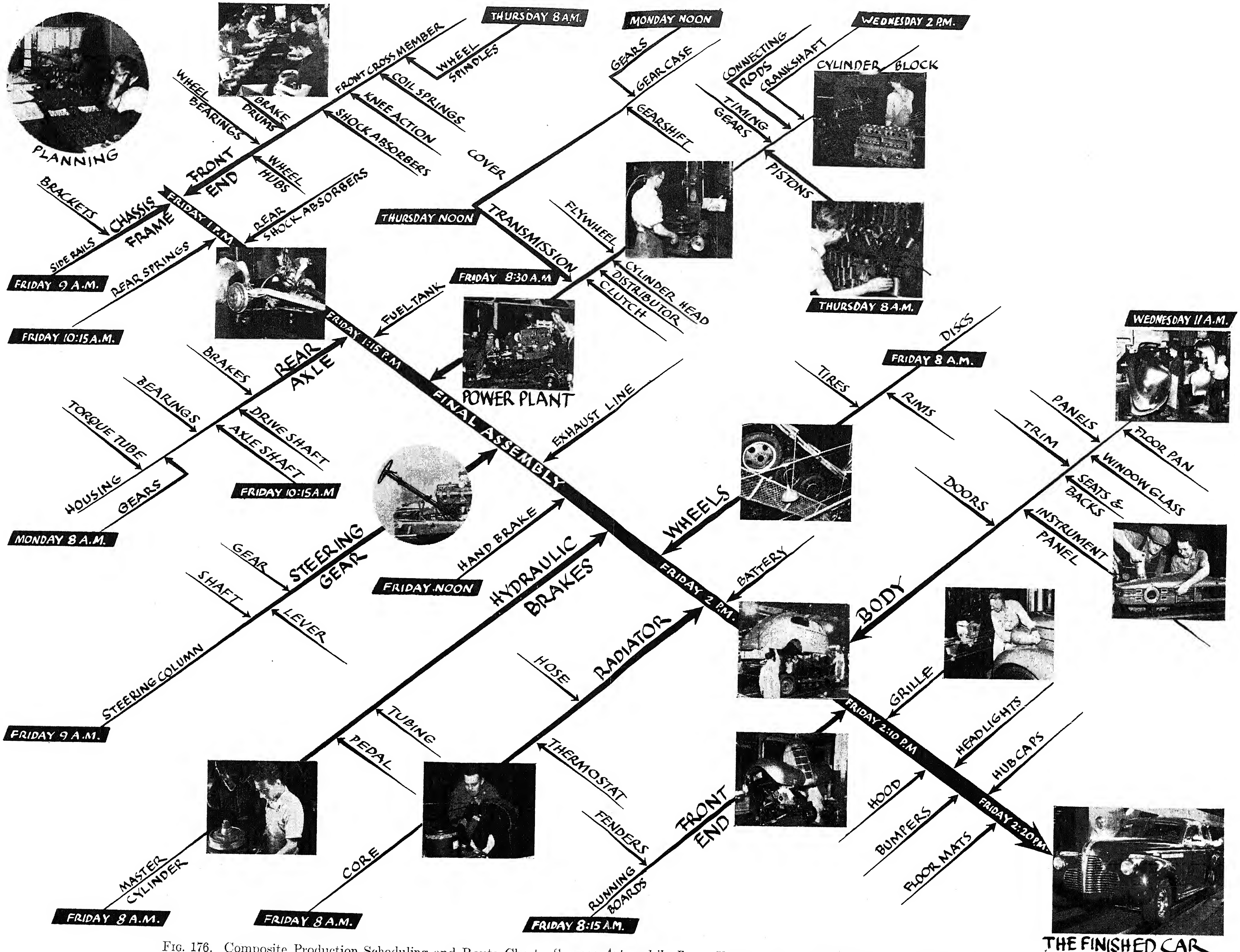

FIG. 176. Composite Production Scheduling and Route Chart. Source: *Automobile Facts*, Vol. II, No. 4, Automobile Manufacturers' Association.

(To face p. 61[illegible])

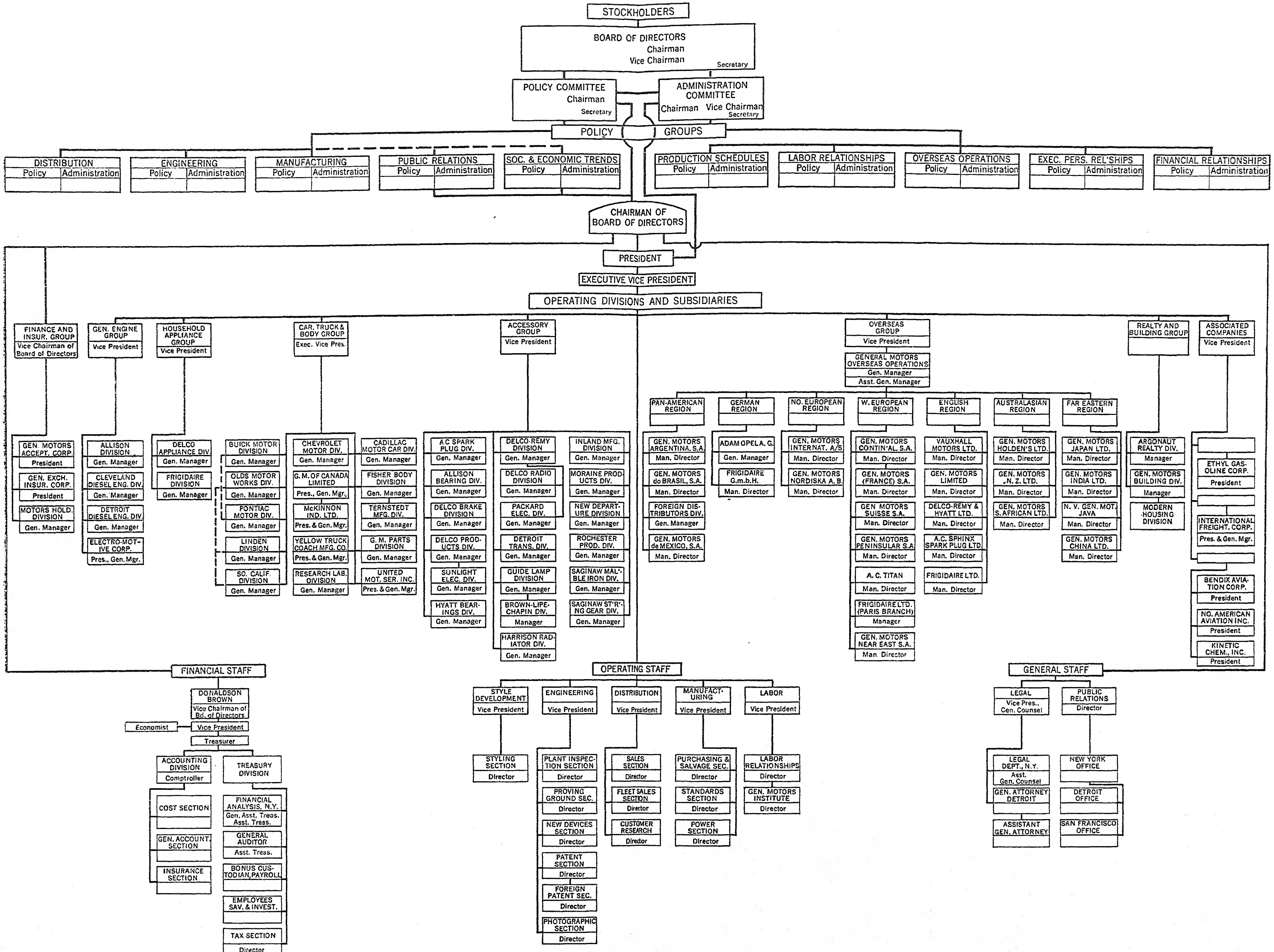

FIG. 10. General Motors Organization Chart.

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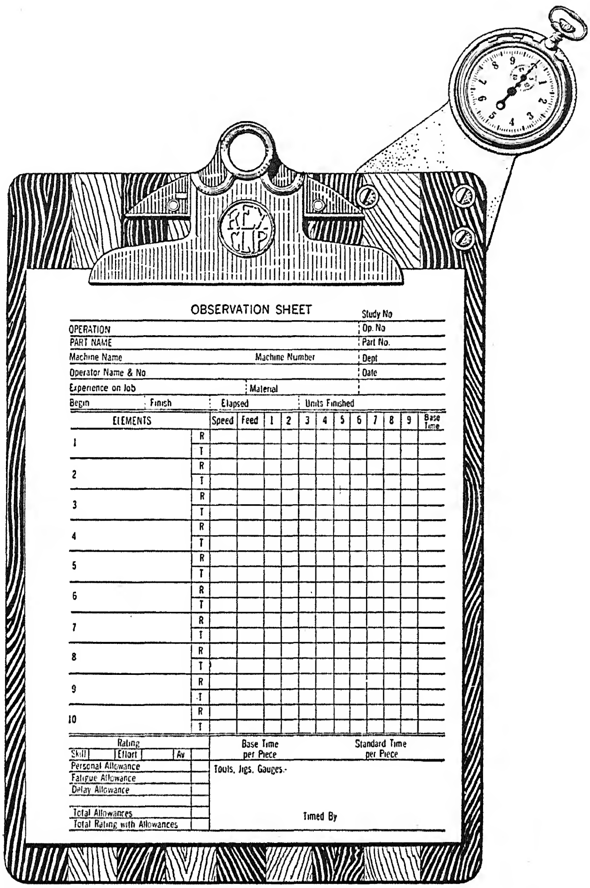
and fractions of a second. This simplifies recording and computing of times. This watch fits into a pocket near the top of the board carrying the observation sheet, and the board is of such a size as to be conveniently carried on the observer's left arm (Fig. 126), so that the work, watch, and observation sheet may all be in a straight line with the



Courtesy Ralph M. Barnes, "Motion and Time Study," p. 190.

FIG. 126. Stop-watch Study Board with Observation Sheet for Recording Data Taken by the Continuous Method.

observer's eye. The use of this equipment will be assumed throughout the following pages.

Frank B. Gilbreth also utilized the motion-picture camera in determining time values, by placing a special clock or microchronometer in the field of vision and obtaining the "therblig times" from an analysis of

the film. This procedure is termed "micromotion study." He built up very satisfactory arguments for the utilization of this method where the elements are short and the work is on a standard product.

The preliminary study. The work of the job-study observer in what may be termed "the preliminary study" is, economically, in many ways more important than the actual recording of times themselves. From a wage-setting standpoint it is of paramount importance also, because it is frequently the work done here that determines the effectiveness of the final study. The "preliminary study" includes all the work prior to recording the actual elementary times observed. It includes the motion study that is taken in order that the work may be done in the most effectual way. It also includes some preliminary time studies taken to check the effectiveness of the motion studies, and to determine and record the elements of the task to be timed.

Having determined upon the operator who will be timed, the observer should spend some time acquainting himself with the work and all conditions which are affecting it, or might affect it. He should observe the conditions under which the raw material is furnished the operator and the facilities which the operator has for disposing of the finished product He should familiarize himself with the quality of the work demanded and the degree of accuracy required. He should see that the necessary equipment for the operator effectively to perform his task is provided and at hand, and, if the operation is a machine one, he should see that there is a sufficient supply of power to drive the machinery to best advantage. Abnormal conditions should be remedied during this preliminary study. Full information should be secured concerning the standards of accomplishment on the job in the past, in order that comparative achievement records may be available after the job has been studied, changed, and timed.

Determining the elements to be timed. Preliminary job studies, in determining the elements to be timed, must necessarily include a detailed study of the methods of job performance. It is in such studies that analysis is made of the motions that the worker takes in doing the work, and it is through the elimination of useless motions and the providing of standard equipment that much of the savings incident to job study are made. In order satisfactorily to carry on a motion study, and in order to secure the basis for an accurate time study, it is important that the job be broken down into its elements. It is only by a study of the elements that it is possible to determine whether the work is being done in the best and cheapest way. An *element* of an operation may be defined as a single continuous and distinct motion or motions of a worker or machine of relatively short duration, the termination of which is indicated to the observer through sight, sound, or touch. In driving a

screw, one element consists of placing the screwdriver in position, and another the continuous twisting of the screwdriver while driving the screw. A more complex operation is necessarily made up of a correspondingly greater number of elements, but each of them must be continuous and distinct. For motion study, and the improving of methods in time study, it is important that each separate element, however small, be analyzed. For the setting of rates, after the method has been established, it is usually desirable to combine several successive short elements, in order that the watch may be read more easily during the progress of the study. It is extremely unwise to try to observe and record elements which follow each other in successions of only a few hundredths of a minute, since an error in the reading of the time on the stop-watch may be as great as or greater than the elapsed time for the element in question. For practical purposes an operation should not be broken down into elements any of which are less than about .04 minutes in duration, particularly if the continuous method of time study is to be used.

In time studies, for rate setting, the extent of separation of the elements is determined by the character of the operation and the length of the elements. For instance, if the product be standard, not varying from day to day, and is made by repeating the same operation or set of operations, it probably will be wise to study the work from the standpoint of complete jobs, possibly lumping the minor elements together. Such time studies may be termed "operation time studies."[1] The attached illustration from the L C. Smith and Corona Typewriters, Inc. plant is an example of such studies. It will be noted that such a sub-operation in reality involves a combination of elements. This is the most common type of time study. If the product varies considerably, and is made by a series of operations, the elements of which may quite conceivably also be found in other operations on the same or similar products, it will be found extremely undesirable to lump any elements, because the time for each separate element may be desired in order that they may be regrouped to ascertain time for the other operations. Thus, by taking a series of time studies on a number of more or less fundamental operations and elements in a shop, it may be possible to arrange and combine data in such a manner that the proper time of performance may be secured for practically every job that the shop may perform, without taking new studies. Such time studies may be called "fundamental element time studies," and in these the time for each separate element is carefully secured.

[1] The term, "operation time studies" is also applied to studies in which the overall operation times are taken without breaking them down into their elements.

After the elements have been determined they are noted in the space provided for them on the observation sheet. In the accompanying example it will be found that six elements have been studied:

1. Pick up, locate, and lock.
2. Drill three No. 40 holes.
3. Drill five No. 48 holes.
4. Drill two No. 9 holes.
5. Unlock and remove.
6. Clean jig.

The standard method of performing the operation is thus determined, with all possible improvements in equipment and method already accomplished, or note made to provide for further improvement at a later date.

Preparing the observation sheet. As another portion of the work preliminary to taking the time study, all information called for in the headings of the observation sheet should be filled in. In establishing the conditions of studies taken for rate setting, it is essential for the observer to see that they are standard and can be repeated at any time. Such complete information makes possible not only the checking of the study while it is being taken, but the checking of it at some future date when the rates set on it as a basis may be questioned. If conditions are carefully noted, they may be readily re-established at any future date, or at least it may be determined wherein new conditions differ.

Complete record should be made of the date of the observation, the observer, the workman and his qualifications, the method of work, and the equipment used. Wherever possible a sketch of the operation should be included, and at times photographs of the operation are taken and included on the observation sheet. Every possible note or dimension which may have any bearing on the manner of doing the work should be entered on the sheet. Many a study has been rendered worthless for later use because the observer failed to record some apparently minor dimension or condition. If the material, for instance a textile, is such that a sample may be secured and attached to the sheet, this might well be done.

Taking the time study. On completion of this preliminary work the observer is ready to begin the actual observations and recording of times. To secure accurate results the observer must stand in such a position that he can see exactly what the worker is doing, and, as far as possible, exactly what the machine is doing also. The observer should be behind, not in front of, the employee. This will lessen the strain of being observed, which increases if the worker tends to look up to see what the observer is "doing now." Ordinarily the correct position will develop to be about 5 to 6 feet in the rear and to the right or left of the employee.

In taking the study the observer will record elapsed time on the observation sheet as indicated in the example. It will be noted that in the spaces following the elements will be found two sets of figures expressed in minutes and hundredths of a minute. Those in the upper space opposite "R" represent the continuous times or "readings," recorded as the study is made for the operation as a whole. Those in the lower space opposite "T" represent the times for the elements, which are computed from the continuous times after the observations have been completed. In the accompanying study the watch was reset to zero at the end of each operation cycle. Some feel that it is desirable to allow the watch to run continuously, and make all observations so as to show the total elapsed time from the beginning of the study. The advantage of this is that necessarily all happenings during the progress of the operation must then be noted and explained on the observation sheet. This practice is particularly desirable in a job study for developing standard conditions, so that all interruptions that have occurred, of whatever character, may be studied with a view to prevention of recurrence. The disadvantage lies in the necessity of entering three figures instead of two for each observation taken after the pointer of the stop-watch has made one complete revolution.

The number of observations of any operation that are required in order to secure sufficient information will vary with the type of work involved. In the illustration one hundred observations were taken. Usually so great a number is not necessary, although in setting rates on work repeated day after day, where the cycle is short, as in the illustration, this may not be too many. This is true particularly if a number of workers are engaged on the same operation. If a comparatively long time is necessary to perform each of the elements of the operation and it is clearly seen that the operator has achieved a rhythm that results in approximately a uniform rate of work, only a few observations, for instance ten to twenty, might be necessary. This is true especially if the job involves work on automatic machines, with but a small percentage of handling time.

Securing the time of each element. At the completion of taking continuous times for whatever number of operations is decided upon, the observer determines the individual time for each element from the continuous times which he has recorded on the observation sheet. They are secured by subtracting the continuous time recorded opposite the prior element from the continuous time for the element in question.

These individual times are usually accurate, because the stop-watch hand will make three forward moves each 0.01 minute. Thus, if the hand were stopped it would be possible to read down to 0.003 minute. However, 0.01 minute is a close enough observation for almost any

purpose, for the observer will ordinarily read up 0.01 minute as often as he will read down 0.01 minute, and any slight errors in observation of this nature will automatically adjust themselves.

Besides the continuous method of securing times for individual elements, there are two other methods which should be mentioned, for it will be found that some time-study men prefer them, especially the second one in special cases. They are the repetitive method and the cycle method. Under the *repetitive method,* the observer starts the watch at the beginning of an element, stops the watch when the element is completed, and records the time of the duration of the element. When the proper time again comes for the element to occur in the operation he again starts the watch, stops it at the end of the element, and records the time taken. Unless the purpose is to take a detailed observation of one motion or element with a view to its particular improvement, this method is wasteful of the observer's time. It does not provide for the securing of information concerning delays and their causes. Furthermore, elements dovetail with each other as the work is performed, and time studies, to be just, should time the worker under actual working conditions. Timing one element at a time is not making the study under actual conditions in every respect.

The *cycle method* is utilized for the purpose of taking the times of very short elements. The use of this method also necessitates the taking of continuous times. The observer takes the unit times of the elements in as many cycles as there are elements, each cycle including one element less than the total number, a different element being eliminated for each successive cycle. Thus, in a cycle having four elements, *a, b, c,* and *d* respectively, the observer as illustrated below would take readings for four cycles. For cycle *1* the watch is stopped at the end of element *c*. For cycle *2* the watch is not started until element *b* is just beginning to be performed. The watch is then stopped at the close of element *d*. For cycle *3* the watch is not started until element *c* is just beginning to be performed. The watch is then permitted to run into the next "operation cycle" and stopped at the close of element *a*. Cycle *4* is the same as cycle *3* save for the fact that it begins at element *d* and continues into the next operating cycle to the close of element *b*. The sum of all the cycles divided by the number of cycles less one gives the operation time. By subtracting the total time of the duration of any cycle from the operation time, the value of the element omitted is found each time. The illustration on the following page contains four elements.

The use of the motion picture in time and motion study work. Frank B. Gilbreth and his wife, Dr. Lillian M. Gilbreth, popularized the technique of time and motion analysis by the use of the motion

Cycle *1*	Elements	$a + b + c +$	$= 0\ 08$
Cycle *2*		$b + c + d$	$= 0\ 07$
Cycle *3*		$a + c + d$	$= 0\ 10$
Cycle *4*		$a + b + d$	$= 0\ 08$
Sum ..		$3a + 3b + 3c + 3d$	$= 0\ 33$
Operation time .		$a + b + c + d$	$= 0\ 11$
Operation time		$a + b + c + d$	$= 0\ 11$
Subtract Cycle *1* .	. . . .	$a + b + c$	$= 0\ 08$
Time of element	. . . . .	d	$= 0\ 03$
Operation time	.	$a + b + c + d$	$= 0\ 11$
Subtract Cycle *2* .	. . . . .	$+ b + c + d$	$= 0\ 07$
Time of element .	. . .	a	$= 0\ 04$
Operation time	. . .	$a + b + c + d$	$= 0\ 11$
Subtract Cycle *3* .	. . . . .	$a + c + d$	$= 0\ 10$
Time of element.	. . . . .	b	$= 0\ 01$
Operation time .	. . . .	$a + b + c + d$	$= 0\ 11$
Subtract Cycle *4* .	. . . .	$a + b + d$	$= 0\ 08$
Time of element	. . . .	c	$= 0\ 03$

Therefore: $a = 0\ 04$
$b = 0\ 01$
$c = 0\ 03$
$d = 0\ 03$

picture. In the beginning a clock with a large dial was placed in the general field of the operator being studied. The time for any given motion of the operator being studied is determined by comparing the clock time in the picture at the beginning of the motion with the clock time at the completion of the motion. The precision with which these time values are determined is dependent upon the divisions into which the clock is made. It is possible to read differences in time as fine as .001 of a minute, and even less, depending upon the speed and other characteristics of the equipment used in taking the pictures. This method of taking time studies is still used but it is rapidly giving way to another technique whereby the camera is run at certain controlled speeds producing a specific number of frames per minute. By this method it is a simple matter to determine the time required for any motion or operation by merely counting the number of frames required to take the motion or operation.

The motion picture method of time and motion analysis has certain advantages other than merely the recording of elapsed time. It provides an accurate record of everything that transpires. It is possible to restudy the operations scientifically without the distraction of production going on at the same time. The film may be run at slow speeds

and thus analyze a particular motion in detail Some operators are so fast that the human eye can scarcely detect them By the use of the motion picture these may be slowed down for analysis and exact time values determined. For instance, it is possible to determine the exact time required for an operator to shift his eye and focus on an object. This would be practically impossible by any known technique other than the motion picture analysis. Waste motions may be studied not only by the observer but also by the operator himself. The motion picture thus becomes not only an excellent device for correction but also a valuable aid in instruction.

The use of motion pictures in time and motion analysis is somewhat expensive but by no means prohibitive. The expense increases proportionately to the length of the operation cycle studied. Another item should be noted, namely, that relatively few time study men are trained in the use of the motion picture technique.

Therbligs. Frank B. Gilbreth designated certain subdivisions of a cycle motion which he thought common to all kinds of work, *therbligs* (Gilbreth spelled backwards). Gilbreth listed seventeen therbligs. Professor Barnes, whose list we are using below, has classified eighteen therbligs. Other investigators have used a different number of therbligs. The therblig is supposed to represent an elemental motion. The most common ones in use are as follows:

1. *Search* [2] (Sh.) refers to that part of the operation cycle during which the hands or eyes are trying to locate the object.
2. *Find* (F.) occurs at the end of *search* and is in reality more of a mental reaction than a bodily movement.
3. *Select* (St.) represents the actual sorting out of one object from among two or more objects. (The three therbligs, *search, find,* and *select* are frequently combined into the one therblig, *select*)
4. *Grasp* (G.) involves the actual taking hold of the object.
5. *Transport loaded* (T.L.) refers to the actual moving of the object from one place to another.
6. *Position* (P.) consists in adjusting the object so that it will be ready to fit into the location for which it is intended.
7. *Assemble* (A.) This therblig begins as the object starts to move into its place in the assembly.
8. *Use* (U.) is the actual manipulating of the tool or apparatus for the achievement of the purpose intended.
9. *Disassemble* (D.A.) is the separating of one object from another.
10. *Inspect* (I.) is the act of checking to see if the work meets predetermined standards.

[2] See Ralph M. Barnes, *Motion and Time Study*, John Wiley and Sons, Inc., New York, 1937, pp. 47-51, for a detailed description of therbligs and their use.

11. *Pre-position* (P P.) refers to the placing of the tool or object in such a position that it will be ready for use when needed. This therblig eliminates the therblig *position*.

12. *Release Load* (R L) is the actual "letting go" of the object.

13. *Transport Empty* (T E) is the moving of the hand empty either in reaching for an object or returning to a given position after the therblig *release load* (R L).

14. *Rest* (R) is a delay factor provided to enable the worker to recover from the fatigue arising from his work.

15. *Unavoidable Delay* (U.D.) arises either from an interruption in processing or a situation in which one part of the body is prevented from working by another body member.

16. *Avoidable Delay* (A.D.) arises from any delay over which the operator has control.

17. *Plan* (P.) arises from the mental processes involved in making a decision of how to proceed or what to do next.

18. *Hold* (H.) signifies the retention of an object after the therblig *grasp* during which time there is no movement of the object. Gilbreth included the therblig, *hold* in his therblig, *grasp*.

The standard symbols and colors for therbligs are shown by the chart on p. 390, Fig. 127.

Micromotion analysis. A micromotion study may be made as the result of a careful analysis of an operation either with or without the aid of a motion picture of the operation. A motion picture of the operation is particularly helpful in that it facilitates getting all the detailed actions of both hands or other members of the body in case they are involved. A micromotion analysis is particularly valuable in calling attention to idle time on the part of one hand which can be avoided by a rearrangement of the sequence of operations. Because of this fact the first micromotion analysis may be merely a tool to aid in perfecting the standard operation desired. When all corrections have been made a final micromotion study serves as a valuable record of the standardized operation. In the construction of what was expected to be a final motion analysis further improvements suggest themselves.

The making of a micromotion study in the form of a simo chart requires considerable time and in many instances is not justified. It is, however, an excellent training device and well worth making from time to time for training purposes if for no other reason. Figure 128 is illustrative of the detail that may be shown of a link-forming operation. Either the simo chart or the analysis sheet of the micromotion study may be made independently. It is not necessary to make the simo chart in order to make the micromotion study.

Synthetic time studies. Where time studies have been made with special care in the selection of the elements these elemental times can be used in the determination of the standard times for other operations containing these same elements. This is true especially when there are

Name of Symbol	Therblig Symbol		Explanation-suggested by	Color	Color Symbol	Dixon Pencil Number	Eagle Pencil Number
Search	Sh		Eye turned as if searching	Black		331	747
Find	F.		Eye straight as if fixed on object	Gray		399	747½
Select	St	→	Reaching for object	Gray, light		399	734½
Grasp	G.	∩	Hand open for grasping object	Lake red		369	745
Transport loaded	T L		A hand with something in it	Green		375	738
Position	P	9	Object being placed by hand	Blue		376	741
Assemble	A	#	Several things put together	Violet, heavy		377	742
Use	U	U	Word "Use"	Purple		396	742½
Disassemble	D A		One part of an assembly removed	Violet, light		377	742
Inspect	I	0	Magnifying lens	Burnt ochre		398	745½
Pre-position	P P.		A nine-pin which is set up in a bowling alley	Sky-blue		394	740½
Release load	R L		Dropping content out of hand	Carmine red		370	744
Transport empty	T E		Empty hand	Olive green		391	739½
Rest for overcoming fatigue	R		Man seated as if resting	Orange		372	737
Unavoidable delay	U D.		Man bumping his nose, unintentionally	Yellow ochre		373	736
Avoidable delay	A.D.		Man lying down on job voluntarily	Lemon yellow		374	735
Plan	Pn.		Man with his fingers at his brow thinking	Brown		378	746
Hold	H.		Magnet holding iron bar	Gold ochre		388	736½

Courtesy Ralph M Barnes, "Motion and Time Study," p 48.

FIG. 127. Standard Symbols and Colors for Commonly Used Therbligs.

many different operations of a similar class of work such as that on lathes, drill presses, punch presses, etc. These elemental times, to be of use in building synthetic times, should be established with great care under standard conditions.[3] When this has been done and a new job

[3] See Ralph M. Barnes, *Motion and Time Study*, pp. 215-217, for an excellent discussion of determination of time standards from elemental time data.

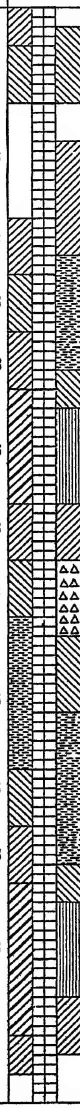
MICROMOTION STUDY

SIMO CHART

PART Link for typewriter	DEPARTMENT 9		FILM NO C18
OPERATION Form link for typewriter			OP NO G11
OPERATOR A S Sanders A2	DATE 2-15-37	MADE BY S A.R	SHEET NO 1 OF 1

DESCRIPTION LEFT HAND	THERBLIG SYMBOL	TIME	TIME	THERBLIG SYMBOL	DESCRIPTION RIGHT HAND
Returns clamping lever and releases it		2			
Moves hand to fixture		3	4		Reaches for material
			2		Selects and grasps one piece
Grasps formed link in fixture		6			
			6		Carries piece to fixture
Carries formed link to left and releases it		3			
Moves to clamping lever and grasps knob		3	6		Inserts piece in fixture and releases it
Moves lever to extreme left		3			
			2		Reaches for forming lever and grasps knob
Holds lever in this position		6	5		Forms 1st end of link
Returns lever to original position and releases it		3	3		Returns forming lever and releases it
Moves hand to fixture		3	4		Moves hand toward fixture and waits for left hand
			4		Moves hand to fixture
Grasps piece, turns it end for end in fixture and releases it		8			
Moves to clamping lever and grasps knob		3	8		Assists left hand in turning piece end for end in fixture
Moves lever to extreme left		3			
			2		Reaches for forming lever and grasps knob
Holds lever in this position		8	5		Forms 2nd end of link
			3		Returns forming lever and releases it
Returns clamping lever and releases it					

TIME IN 1000THS OF A MIN



Courtesy Ralph M Barnes, "Motion and Time Study," p. 86.

FIG. 128. Simo Chart of Link-forming Operation.

is to be undertaken, all that is necessary is to construct a detailed operation sheet for the task and select the appropriate elemental times for each element from time values already established for similar work. When this is completed the total of the elemental times, when adjusted for allowances for fatigue, etc., gives the operating time allowed for the operation.

The use of synthetic standard times enables the production department to plan its schedules even before the first piece has been produced. Such a program is particularly valuable in estimating the cost of producing parts when quotations are asked with only the blueprint specifications available.

Synthetic time studies from elemental body movement time values. A few time-study men have contended that elemental times can be determined for the movements of the various body members and that the operation elements for a particular job can be in turn computed by combining the therblig time values for each operation element. The procedure for using body movement time values for determining operating times is as follows:

1. Separate the operation into its basic elements.
2. Separate each operation element into its therbligs or elemental body movements.
   a. In case two or more body movements are executed simultaneously, the time required for the longest therblig is controlling.
   b. In some cases simultaneous body movements do not have the same time elements as each does when executed alone. This difference must be allowed for in computations.
3. Assign time values for each therblig in each operation element.
4. Total the time values for each therblig in each operation element.
5. Add allowances for fatigue, etc. to determine the required operating time.

Synthetic time values for industrial operations derived from basic therblig standard times have not as yet received general acceptance in industry. This field for pure research is a fertile one. Should it be definitely established that these body movement time values are constant or vary in a determinable ratio, this method of establishing operation time values will revolutionize our present method of time and motion study. Under this system the observer would not require a stop watch or other timing device. He would merely motion study the operation, establishing carefully the operation elements and their resulting therbligs. He would return to his office and fill in the time values for the body move-

ment therbligs, add the machining time [4] required and allowances for fatigue, personal needs, etc. to establish the operation time.[5] At least one large manufacturer in Chicago is experimenting with such a program. The results achieved to date seem encouraging.

[4] Machining time can usually be supplied by the manufacturer of the machine In case these data were not available, it would of course be necessary to establish such standard times by actual checking with some type of timing device

[5] See Walter G Holmes, *Applied Time and Motion Study*, The Ronald Press Company, New York, 1938, pp 217-280, for an excellent discussion of body movements and time values for same.

CHAPTER XXXI

SETTING RATES BY TIME STUDY

Ascertaining selected operation time. After the time for individual elements has been secured from the observation sheets, the proper time for performing each element and the whole operation may be determined. It will be assumed that the method of taking times illustrated by the L. C. Smith and Corona Typewriters, Inc., observation sheet has been used. Several methods of working up the time-study results will be described. They may be termed the "average" method, the "minimum" method, the "modal" method, and the "good time" method. They will each be described; but prior to taking them up in detail, there will be pointed out certain features which are common to them all.

The *first step* in any method is to throw out the "abnormal" times. These are times recorded for individual elements that are clearly in error when compared to the other times recorded. The error may be due to one of the following causes:

1. Some delay which will seldom occur or some variation in the way that the element was performed which will seldom be repeated.

2. The wandering of the worker's attention, for instance, talking to a fellow-workman. A certain degree of lack of attention to a job is not only likely to occur, but is desirable, if undue strain is to be lifted from the workers. Such time as is necessary for this, however, should not be included in operation time, but added in the form of an allowance, after operation time has been determined. Other allowances must be added in like manner.

3. Some mistakes on the part of the observer in reading the watch, which can generally be noted by the fact that the time of either the preceding or the succeeding element is likely to be abnormal, whereas the sum of the two abnormal times will be approximately the sum of the average times of the two elements.

Striking out abnormal values, either higher or lower than the general average, calls for fine judgment on the part of the observer. Nevertheless, *it may be assumed that any time which varies more than 25 or 30 per cent from the average may be stricken out of the calculations.* On short elements it is not always practical to adhere to the percentage basis. Thus, no observations have been stricken out on the attached example.

There are a few kinds of work in which the abnormal values should be figured in, when working up the study. These include construction work and repair work.

According to the "average" method, which is the simplest, those individual element times which remain after the abnormal readings have been eliminated are averaged. A more appropriate name for this method of selecting the operation time would be the *"selected average"* method. (An occasional observer may use the straight mathematical average or mean without discarding abnormal times. Such a plan is absurd when some of the readings are obviously abnormal but it would probably cause no special difficulty where the variations are only on the borderline of being abnormal.) If the average method were used, these average times would also be the selected times and would be so indicated in the last column of the observation sheet. The selected operation time under this method is found by adding up the average time of the separate elements. The objection to this method is that it may make the individual element times and hence the final operation time too high, because it includes all observations other than those which were abnormal. In adding allowances, these higher times are automatically taken care of, and this method has the effect of giving too much weight to the higher times.

The *"minimum"* method provides for taking the absolute minimum for each element, namely, that time which, in all the observations, was the fastest for any one element, and then adding these together to get the selected operation time. (The minimum method excludes the abnormal times before selecting the minimum. It will be recalled that the first step in all of these methods was the casting off of all abnormal times.) In this method, therefore, the minimum time and the selected time are the same. This has the effect of materially reducing the selected time below that which would be found under the "average" method. For instance, in the illustration given, the selected time for the complete operation cycle of six elements would, under the "average" method, be 1.2648 minutes, while under the "minimum" method it would be 1.13 minutes. It is generally held that this method is too severe and is not fair to the workman, even with the addition of allowances, since to choose the minimum time, which might have occurred only once out of twenty observations, usually means taking a time that is just over the 25 per cent borderline, and is not quite thrown out.

The "modal" method is one of the two most frequently used. It consists of taking the most frequently recurring element time in the observations as the time for that element. Thus, in element six in the illustration, the time 0.07 recurs 47 times, whereas the times which recur next most frequently are 0.08, 34 times and 0.06, 13 times. There-

fore, 0.07 would be taken as the selected time for that element. The selected operation time is secured by adding together the various element times, thus secured. If two elements recur with equal frequency, usually the average of these elements is taken. Under this method, the selected times for the elements in the illustration would be as follows:

1—0 10 (40 times)	4—0 16 (40 times)
2—0.33 (30 times)	5—0 06 (43 times)
3—0.54 (29 times)	6—0.07 (47 times)

The selected operation time in this case would, therefore, be 1.26 minutes, which is just less than the average time. Usually the modal time is more pronouncedly less than the average time and is, of course, always greater than the time secured by the "minimum" method. The modal method eliminates the objections to the two previous methods, and at the same time gives a selected time which can be achieved, as is evidenced by the fact that it is composed of the elementary times which were themselves most frequently achieved.

The "good time" method is merely the modal method applied with some degree of flexibility. In the "good time" method a time which recurs with reasonable frequency is selected rather than the one which happens to occur most frequently. The fact that the time recurs a number of times indicates that it can be made, and the justice of this method lies entirely in the interpretation of "reasonable." *A time to be reasonable certainly should appear in from 10 to 15 per cent of the observations. The time selected might presumably be the modal time, but it is likely to be somewhat lower.* In the illustration, but one element would be changed, but this is somewhat unusual. That element would be number three, where 0.52 occurred 25 times, 0.53 occurred 28 times, and 0.54 occurred 29 times. 0.53 has been selected, thus making the selected time for the whole operation 1.25 minutes, as indicated.

Leveling factor. If the worker studied is an *average worker,* possessing *average skill,* working under *average conditions,* exerting *average effort,* and maintaining this effort with *average consistency,* the selected operation time discussed above will need no adjusting. On the other hand, to the extent that the observed worker varies from the average skilled worker, an adjustment of the time will need to be made either in the allowances, by empirical judgment, or according to some scale that has been derived by experience. Some time study men argue strenuously against any formula type of leveling factor.[1] It is undoubtedly true

[1] See Walter G. Holmes, *Applied Time and Motion Study,* The Ronald Press Company, New York, 1938, p. 200; also Ralph Presgrave, "Effort Rating" in Society for Advancement of Management, *Quarterly Journal, Advanced Management,* Vol IV, No. 5, pp. 126-133.

that the use of the table described below requires judgment of the same type that is necessary in making adjustments empirically. The table, however, has at least one value. The observer is definitely required to evaluate at least the four factors of relative skill, effort, conditions under which work was performed, and consistency of work. A conscious effort to evaluate these four factors will tend to greater uniformity in leveling than an over-all estimate not broken down.

TABLE 9

PERFORMANCE RATING CHART *

Skill			Effort		
+0 15 +0 13	A1 A2	Superskill	+0 13 +0 12	A1 A2	Killing
+0.11 +0 08	B1 B2	Excellent	+0 10 +0 08	B1 B2	Excellent
+0 06 +0 03	C1 C2	Good	+0 05 +0 02	C1 C2	Good
0 00	D	Average	0 00	D	Average
−0 05 −0 10	E1 E2	Fair	−0 04 −0 08	E1 E2	Fair
−0 16 −0 22	F1 F2	Poor	−0 12 −0 17	F1 F2	Poor
Conditions			**Consistency**		
+0 06	A	Ideal	+0 04	A	Perfect
+0 04	B	Excellent	+0 03	B	Excellent
+0 02	C	Good	+0 01	C	Good
0 00	D	Average	0 00	D	Average
−0 03	E	Fair	−0 02	E	Fair
−0 07	F	Poor	−0.04	F	Poor

* Stewart M Lowry, Harold B. Maynard, G. J. Stegmerten, *Time and Motion Study*, McGraw-Hill Book Company, Inc., New York, 1932, p. 135. Reproduced by permission of the publisher.

The selected time value taken from the observation of the worker is adjusted to correspond to the time that might reasonably be expected of an average worker. This is accomplished by multiplying the selected

time by a leveling factor. This leveling factor is obtained from the accompanying table (Table 9) according to the following illustration. Assume that the worker possessed excellent skill (B1), worked under fair conditions (E), exerted good effort (C1), and was average (D) in consistency. The numerical equivalent for each of these factors added to unity algebraically would be the leveling factor, $.11 + (-.03) + .05 + .00 + 1 = 1.13$. Since the observed worker is above the average it would be expected that his time would be shorter than the time required of the average man. By multiplying the selected operation time by 1.13, the time for the average worker would be determined. This time would still have to be corrected for allowances for personal needs, machine set-up time, etc.

Time-study allowances. As previously indicated, there must be added to the ascertained normal time certain allowances, through which provision is made that the standard time set for a job shall be capable of accomplishment over long periods. These allowances include:

1. Allowance for the preparation time of the machine. It will be noted that the machine will have to be prepared to do a job only once, although the job may be repeated many times in succession. This is therefore in the form of an allowance rather than an element of the operation.
2. Allowance for necessary machine delay.
3. Allowance for fatigue of the operator.
4. Allowance for personal needs of the operator, oiling machine, etc.

The preparation allowances may sometimes be determined with as much exactness as the selected time. On the other hand, the provision of proper allowance for machine delay, fatigue, and personal needs must involve as an element the judgment of the person who computes the allowance. Therefore, *if care be not utilized in the making of the allowances, any amount of care utilized in timing of the operation or selecting the unit times may be voided.*

The taking of time studies for the purpose of setting rates furnishes a basis on which definite standard times may be set. *The selected operation time is the time in which the operation could be performed by a highly skilled worker under ideal conditions.*

Standard time. The selected operation time is a time that can be "made," but not one that is usually made. This manifestly would be an unfair basis for the setting of rates. It is desired to fix a time that will be within the ability of any worker, properly instructed. This time is secured by leveling the selected operation time and adding the allowances, and is known as "standard time."

The measure of the *fairness* of the standard time which has been set is the ability of the *average worker to make it,* and the ability of the

extra-skilled worker, working under good conditions, to excel it. The purpose of time study is to set a time which may cause the worker to accomplish the maximum amount of work with the minimum amount of fatigue, as only with such a time standard can maximum production be maintained day after day. The selected operation time is not such a basis, but would only be a basis for setting a standard for a highly skilled worker, working under ideal conditions.

The relationship of the allowances to standard time is important. One of the chief criticisms leveled at time study has been that it sets a rate which only the best workers can hope to achieve. The addition of proper allowances changes the normal time to a standard time which the average worker should better consistently if properly trained, while the better worker will be able to excel the standard time consistently. Indeed, some newer wage systems depend upon the fact that standard time can be consistenty exceeded.

Preparation-time allowances. The first allowance which may be made is for preparation time. In any type of work that is not purely a manual job there is involved some preparation of the machine to receive the work that is to be done. The "set-up" of the machine from the last job must be changed. The importance of this, the length of time that it takes, and the frequency with which it must be done, differ from job to job and from industry to industry. Preparation time may not always be treated as an allowance. The preparation of the machine may in some cases be regarded as a separate operation, or it may be wiser to regard it as an element of the operation to be performed.

In by far the largest number of operations, the machine is "set-up" once and then the operation is performed several or a number of times in succession prior to the resetting of the machine. It is in such cases that a preparation *allowance* is necessary. Illustrations of such jobs are to be found in great number in many industries, for instance, in shoe-manufacturing and in any work requiring the use of machine tools. The "pulling over" machine in a shoe factory must be reset for each type of shoe being worked upon. But many dozen shoes are worked on prior to the resetting of the machine. If the operation being studied is the pulling-over of a shoe, it will be seen that the preparation time of the machine must be figured in the necessary time for the performance of the operation, but that it may be figured in terms of an allowance. There should be determined, as in the case of the loom, the length of time it takes to set up the machine, as though it were a separate operation. This amount may then be divided by the number of shoes being made in a given case, and the result may be added to the selected operation time taken to work one shoe, so that each shoe may bear its proper part of the time that it takes to set up the machine to work on the whole lot.

For instance, if the set-up time is found to be 48 minutes, and there are 20 dozen shoes being run through, the preparation allowance would be 0.2 minute per shoe. If 40 dozen shoes were to be run through before the machine were reset, the preparation allowance would be 0.1 minute per shoe.

Allowance for personal needs. The amount of time required for personal needs will probably vary more with the individual than with the type of work; however, with the same individual more time will be required for personal needs when performing heavy work or when working under unfavorable conditions of humidity, heat, etc., than when doing light work or laboring under more favorable conditions. It is not unusual for women to require more time for personal needs than men working under the same conditions. The allowance for the personal needs of the workman is usually constructed so as to take care also of the regular oiling and care of the machine. This allowance is sometimes known as the "shop constant" because it is usually the same for all operations in the shop. It is ordinarily based on a percentage between 2 and 5 per cent of the selected operation time.

Delay allowances. Delay allowances include allowances for the lost time due to occasional variations in material and interruptions by supervisors, and machine delay allowances for delays due to difficulties with machines or equipment, which may be outside the control of the operator. It is in the making of the delay allowances that the most care is needed, because these may be so large that unless they are carefully set, all the previous care taken in making and working up the study may be wasted. The question may appropriately be asked—why carefully record element times to 0.01 of a minute, and then add a delay allowance of "between 20 and 50 per cent at the discretion of the observer, based on his opinion as he took the study?" Yet many time studies have been worked up on that basis. It is one of the most common practices connected with time study. It is also one of the chief causes of criticism of time-study work, as practiced.

Fatigue allowances. In setting the fatigue allowance there are a number of factors to be considered. The first of these is the working conditions. If these are excellent, that is, if the shop is clean, well lighted, and well ventilated, they may be disregarded, as far as fatigue arising from general working conditions is concerned. If these conditions are not right and cannot be immediately made right, allowance must be made. The next factor is the length of the cycle of the operation. In general, the shorter the cycle, the greater the necessary fatigue allowance. The amount of physical exertion required must also be considered. If a job requires much physical exertion the influence of the fatigue factor is large. On such jobs, however, the original study should extend over a

large portion of a day, in order that the fatigue factor may directly influence the selected operation time. The presence or absence of stated rest periods should also be considered.

The study of fatigue. The fatigue of workers is the uncontrollable item which has made difficult all attempts to develop standard times which will hold over long periods. Attempts to make high wages on piece rates, and enthusiasm upon the part of the worker may both contribute toward the setting of a standard time which seems possible of achievement over long periods, whereas it is really attainable only in spurts.

Physiologically speaking, fatigue is the result of poisonous waste matter in the system and, since all labor produces this waste matter, to eliminate fatigue is to eliminate labor. There are two kinds of fatigue, normal and cumulative. Normal fatigue is weariness that is overcome by rest and need not be considered as an industrial problem; it may even be thought of as a wholesome fatigue which is similar to the pleasure derived from exertion in sports. Cumulative fatigue, resulting from overstrain, can be caused by too much work, too sustained work, or too monotonous work.

The influence of monotony is immeasurably greater than is ordinarily suspected. On the other hand, many operations frequently termed monotonous are far from objectionable to many operators. The attitude of the worker toward his work is largely controlling as far as monotony is concerned. Certain general principles may be stated with a fair measure of accuracy as follows: [2]

1. Monotony is less likely to arise when the machine is entirely automatic.
2. Monotony tends to be reduced when the machine operation requires a high degree of concentration.
3. Monotony is most likely to occur when the machine operation requires the worker to be ever watchful, yet not enough care is necessary to keep his mind fully occupied.

Signs of the presence of cumulative fatigue may be found in a study of production or accident records within an organization. If production tends to fall toward the end of the day or the end of the week, or if accidents seem to be unduly high at these times, it may be assumed that in the operations affected there is some cumulative fatigue which should be eliminated. These guides, particularly the guide of decreased production, may not be sufficient to detect the presence or absence of

[2] See: Elton Mayo, *Human Problems of an Industrial Civilization*, Macmillan Company, New York, 1933; also, H. M. Vernon, *Industrial Fatigue and Efficiency*, George Routledge & Sons, Ltd., London, for a detailed discussion of this subject.

cumulative fatigue. This is true particularly on piecework. Piece workers, who have set a goal for themselves, are very likely to aim to reach this goal regardless of their physical condition, and the curves of production of piece workers, because of this fact, tend to go up at noon and at the end of the day.

Rest periods.[3] Fatigue elimination to date has largely consisted of the bettering of equipment, as discussed under standard equipment; the elimination of useless and tiring motions, as developed by job study; varying the job so as to relieve monotony; and providing rest periods. Rest periods have been developed to provide a minimum of stated rest at intervals throughout the day, although a few companies, while providing the total minutes of rest periods which must be taken through the day, allow these to be taken by the worker whenever desired.

Stated rest periods of five, ten, or fifteen minutes during the morning and the afternoon are particularly successful with female workers. They are successful especially if machinery can be stopped during these times.

Professor Ralph M. Barnes[4] has pointed out that rest periods are desirable in both light and heavy work for the following reasons:

1. Rest periods tend to increase the amount of work done in a day.
2. Rest periods are pleasing to the workers.
3. Rest periods tend to encourage the worker to maintain a level of performance nearer to his maximum capacity.
4. Physical fatigue is reduced by rest periods.
5. Rest periods reduce the amount of personal time taken out during the day by the worker.

Machine-delay allowances. In determining the machine-delay allowance, the percentage of machine time, as contrasted to the manual or "handling" time, should be taken into account. If the machine time be large, the machine-delay allowance must be correspondingly large, because of the greater likelihood of stoppages outside the control of the operator. Since this allowance makes provision for all details outside the control of the operator, it necessarily will be smaller in plants having well-developed planning departments and where material and equipment standardization has been given most consideration. The 10 per cent allowance made in the accompanying illustration from L. C Smith and Corona Typewriters Co., Inc., plant is relatively low and could not be justified in a plant which had not made the progress in these other phases of management work that have been made in this organization.

[3] See: Ralph M. Barnes, *Motion and Time Study*, John Wiley & Sons, Inc., New York, 1937, pp. 99-110.

[4] Ralph M. Barnes, *op. cit.*, p. 105.

The correct percentages of delay allowances in any shop may best be determined by intelligent consideration of the first jobs studied and on the basis of the experience on these jobs for later jobs. That is, after jobs have been studied, and standard times put into effect for them, records should be carefully made of operators' performances, and these should be compared for all jobs of similar percentages of machine time and for similar cycles and amounts of physical exertion required. If the percentage increases of actual handling and machine times be thus compared with selected times, excellent data will be secured for the setting of delay allowances. The most scientific work along these lines has been described by Dwight V. Merrick, the formulae having been developed by the management movement's best mathematician, Carl G. Barth.[5]

Total operation time. After the allowances have been computed, the total allowed or standard time which is set for the operation is computed by multiplying the selected operation time by the leveling factor and adding the allowances. Thus the task time for the operation timed, Fig. 125a, is found to be:

	Minutes
Selected operation time multiplied by leveling factor[6] = 1.25 × 1.1	1.375
Preparation time (not distributed)	.000
Personal needs (3%)	.041
Fatigue allowance (2%)	.027
Machine delay (10%)	.138
Task time	1.581

[5] See D. V. Merrick, *Time Studies for Rate Setting*, Engineering Magazine Co.. New York, pp. 60-65.

[6] This leveling factor is used on the assumption that the worker was A1 in skill, working under poor conditions (F), exerted good effort (C2), with average consistency (D). See Table 9 for values.

CHAPTER XXXII

UTILIZING TIME-STUDY DATA

Regrouping old elements to set times on new operations. In shops manufacturing diverse products, it is impractical to take time studies on many orders being manufactured, because of both the cost and the promise of early delivery dates. It was shown previously that if the operations, when studied, are divided into their basic elements, these element times may be regrouped, and operation times set for new operations without further study. To be in a position to compile time standards in this way implies not only excellent studies to begin with, but a well-worked-out filing system for the data that have been secured. Standard nomenclature of operations is a great aid here.

Much opposition is likely to develop to setting rates by a regrouping of elements unless this is carefully handled. It will be found true that there are comparatively few elementary operations performed in most trades, but that there are a great many combinations in which these few elementary operations may be performed. Nevertheless, great care must be exercised in re-using time-study data, to insure that the element in question is in reality the same element studied previously, and that the conditions surrounding the new job are of such a nature that the information already secured may be freely utilized without injustice to either the workmen or the management.

Synthetic times and the use of elemental time values were discussed in detail in the previous chapter. In many instances a skilled estimator, supplied with accurate studies of similar jobs and cost data, can sit down in the office of his customer and give him a price on a new job that exists only in blueprint form. This practice is not uncommon among parts manufacturers that sell to larger manufacturers.

Setting standard rates. Time studies of the kind which have been discussed are taken not only for the purpose of improving conditions, but for the purpose of setting just and equitable relative rates on jobs. The fundamental consideration in rate setting is that a rate once set must never be cut by the management. Any other policy results in workers being fearful of turning out maximum production, lest the rate be cut. A more complete discussion of the evils of rate cutting will be found in Chapter XXXIII. Therefore, extreme care is necessary to

insure that the rate is correct in the first instance. The actual setting of the rate may be in the hands of the rate-setting department, the superintendent or works manager, the personnel department or whatever group possesses this important responsibility in the organization. It is the methods department, or whatever department of the plant actually makes the time studies, which has the major responsibility. Some system of proposal for a standard rate by this department is usually in vogue, and the accompanying illustration of a standard rate proposal from the L. C. Smith and Corona Typewriters, Inc., plant (Fig. 129a) is an excellent example. It will be noted that the proposed rate covers the same job as the illustration previously used in connection with job studies. The rate is approved by the works manager only after it has been carefully checked by the chief of the planning department and himself.

A guarantee may be given the workman that the rate set will not be cut. This is usually placed on the instruction card which he receives. The policy of the L. C. Smith and Corona Typewriters, Inc., is an excellent example of what plant policy should be in rate guarantees; the printed guarantee which goes to the workman along with the instruction card is reproduced in Fig. 130.

Instruction cards. The preparation and distribution to the worker of instruction cards, carefully detailing the method of work on a job, as well as the time that the various elements should take and the rate of pay, is an important follow-up of time-study work. This insures the utilization of the standard methods which have been devised during the job study and gives to each worker the best knowledge on methods of performance. It does not preclude innovations on the part of the worker, since he may recommend improvements, but it does insure that any new methods which are used will be better than old ones and that they will be equally available to all workers on a particular task. Some incentive must be offered to the worker to suggest improvements; he may possibly be allowed personally to retain the full benefits of any new methods which he may discover; he may receive special recognition in the form of vacations, etc., or he may be paid a flat reward for his suggestion.

Two forms of instruction cards are illustrated. The one used by the L. C. Smith and Corona Typewriters, Inc. (Fig. 131a) is a logical follow-up of their whole method of making job studies. Figure 132a illustrates an instruction card used by the Leeds and Northrup Company, manfacturers of scientific instruments. The relation of set-up time to productive time is clearly shown on this sheet. It also indicates necessary tools.

Instruction cards as an aid to methods. Since methods improvement is one of the two purposes for taking job studies, the instruction card

164-7176-1500 12-20

PROPOSAL FOR STANDARD RATE AND TIME ALLOWANCE

L C SMITH AND CORONA TYPEWRITERS, INC

OPERATION #4 DRILL ALL HOLES. PART NO 2X92.

TO COST DEPARTMENT DATE 8 - 5 - 19

Please furnish the Method and Instruction Card Division with costs of the above operation as follows.

	PER 100 PIECES			
	MATERIAL	DIRECT LABOR	BURDEN	TOTAL COST
AVERAGE COST FOR LAST SIX MONTHS PREVIOUS TO 8 - 1 - 19	-	$ 2.64	-	-
" " " THREE " " " 19	-	2.473	-	-
HIGHEST " " " " " 19	-	3.161	-	-
LOWEST " " " " " 19	-	1.922	-	-

PRESENT RATE PAID AT PIECE WORK $ NONE FOR EACH 100 PIECES PRESENT BASE RATE NONE PER HR

REMARKS THIS OPERATION IS NOT SET ON PIECE WORK - FIGURES GIVEN ABOVE ARE FROM WAGE PAYMENTS OF HOURLY RATES.

REQUESTED BY H. V. WILLIAMS DEPT 52

To be filled in by Methods and Instruction Card Division

	PER 100 PIECES		
	HOURS AT P W	HOURS AT D W	TOTAL AVERAGE
AVERAGE TIME TAKEN DURING LAST SIX MONTHS PREVIOUS TO 8 - 1 - 19	-	6.60	6.60
" " " " " THREE " " " 19	-	5.82	5.82
HIGHEST " " " " " " " " 19	-	7.23	7.23
LOWEST " " " " " " " " 19	-	4.80	4.80

PRESENT STANDARD TIME ALLOWED NONE HRS PER 100 PIECES PRESENT CLASS OF LABOR MALE

REMARKS FIGURES GIVEN ABOVE ARE FROM OPERATION RUNNING ON AN HOURLY RATE BASIS.

PROPOSAL BASED ON OBSERVATION SHEETS 8 - 10 -

PROPOSED STANDARD TIME ALLOWANCE 2.39 HRS FOR EACH 100 PIECES

PROPOSED STANDARD RATE TO BE PAID $ 1.37 FOR EACH 100 PIECES

PROPOSED BASE RATE AT 100% EFFICIENCY $.57 PER HOUR

PROPOSED CLASS OF LABOR MALE

	AT 100% EFF.	AT 80% EFF.	AT 120% EFF.
PRODUCTION REQUIRED PER HOUR	41.75 PIECES	33.4 PIECES	50.1 PIECES
" " " 9½ HOUR DAY	396.6 "	317.3 "	475.9 "
" " " 52½ " WEEK	2191.8 "	1753.5 "	2630.2 "
EARNINGS PER HOUR	$ .57	$ .456	$ .684
" " 9½ HOUR DAY	$ 5.42	$ 4.33	$ 6.50
" " 52½ " WEEK	$ 29.93	$ 23.94	$ 35.91

ESTIMATED LARGEST FIGURES TO BE MADE ON THIS JOB — EFFICIENCY 115 % EARNINGS $ .656 PER HOUR

		%	M PER HR.	M PER 9½ HR DAY	M PER 52½ HR WEEK
ALLOWANCE MADE	— PERSONAL	1.8	17.1	94.5	
"	— FATIGUE	1.2	11.4	63.0	
"	— MACHINE & TOOL	6.0	57.0	315.0	
"	— INSPECTION	-	-	-	
"	—	-	-	-	
TOTAL ALLOWANCES		9.0	85.5	472.5	

FIG. 129a.

Actual working time required (minus all allowances):

PER HOUR 51 MIN. PER 9½ HOUR DAY 8 HRS. 4.5 MIN. PER 52½ HR WEEK 44 HRS. 37.5 MIN

Lost in production due to allowances:

PER HOUR 6.257 PIECES. PER 9½ HOUR DAY 59.44 PIECES. PER 52½ HR WEEK 328.49 PIECES.

GAIN or LOSS made by this proposal (at 100% Eff)

GAIN IN PRODUCTION OF 24.57 PIECES PER HOUR COMPARED WITH FIGURES FOR LAST 3 MOS PREVIOUS TO 8-1-

LOWER DIRECT COST BY $ 1.103 PER 100 PIECES " " " " 3 " " 8-1-

LOWER TIME OF 3.43 HRS PER HR " " " " 3 " " 8-1-

GAIN TO OPERATOR DUE TO OPPORTUNITY TO INCREASE WAGES THROUGH PIECE WORK AND USE OF HIS TIME TO BETTER ADVANTAGE.

STATEMENT OF REASONS FOR CHANGE IN STANDARD AND GAINS OR LOSSES MADE

THIS OPERATION HAS NOT PREVIOUSLY BEEN SET ON PIECE WORK.
FROM THE GIVEN FIGURES, IT WILL BE OBSERVED THAT, UNDER THE METHOD OF PAYMENT BY HOURLY RATES, THERE HAS BEEN A VAST VARIATION IN THE OUTPUT OBTAINED PER HOUR AND THE COST PER UNIT - THIS VARIATION EXISTING WITH ALL OPERATORS TO A GREATER OR LESS EXTENT.
TO CORRECT THIS, IT IS PROPOSED THAT A STANDARD TIME AND RATE, AS GIVEN BE PLACED ON THIS OPERATION - COMPLETION OF THIS WORK IN ACCORDANCE WITH THIS STANDARD AT 100% EFFICIENCY, WILL RESULT AS FOLLOWS:- AN INCREASE OF 24.57 PIECES PER HOUR IN OUTPUT; A DECREASE IN COST OF $1.103 PER 100 PIECES AND A SAVING IN TIME OF 3.43 HOURS FOR EACH 100 PIECES PROCESSED, WHEN COMPARED WITH THE CONDITIONS EXISTING DURING THE THREE MONTHS PREVIOUS. ON A BASIS OF AN ESTIMATED YEARLY PRODUCTION OF 100,000 UNITS, THIS WILL EQUAL A SAVING IN TIME OF 3430 MAN HOURS AND A SAVING IN DIRECT WAGE OF $1103. (NOTE-THE PROPORTION OF DIFFERENCE BETWEEN THE HOURS SAVED AND THE WAGE SAVED, IS DUE TO THE ESTABLISHING OF A BASE WAGE AT 100% EFFICIENCY CONSIDERABLY HIGHER THAN THE AVERAGE HOURLY RATES PREVAILING UNDER DAY WORK CONDITIONS, THUS ABSORBING A LARGE PART OF THE ACTUAL MONEY SAVING MADE.)

THESE PROPOSED SAVINGS ARE MADE THROUGH SIMPLIFICATION AND ELIMINATION OF UNNECESSARY MOVEMENTS AND GREATER APPLICATION OF THE OPERATOR TO THE JOB, THROUGH THE STIMULUS OF PIECE WORK.

NO EXPENSE IS INCURRED FOR NEW TOOLS OR EQUIPMENT OTHER THAN A TOTE BOX FOR DELIVERY OF TOOLS TO JOB - ESTMATED AS $.75 CENTS.

NO CHANGE IN STANDARD TIME OR RATE WILL BE MADE BY THE TIME STUDY DIVISION ON ANY JOB UNLESS THE PROPOSED SCHEDULE IS AUTHORIZED BY PLANNING ENGINEER'S AND WORKS MANAGER'S SIGNATURE

WRITTEN BY H. V. WILLIAMS DATE 8-12-
TIME STUDY DIVISION

ACCEPTED BY

PLAN ENG

WKS MGR

FIG. 129b.

is invaluable in crystallizing for future use the best method for the job that has been developed by the study. Therefore, full information concerning set-up, tools, and methods of handling materials and tools is indispensable on instructions. If a worker, through his own initiative, can find a better way to do the job than that on the instruction card, every facility should be offered him to report this to the methods or time-study department. This forms one of the logical reasons for a suggestion-reward system, but such improved method should be treated as a suggestion, and the job method changed. On new work which is not likely to be repeated, the instruction card forms a means of securing a profitable method from the first. On work which is repetitive, after the first few times that the operation is performed, the instruction card is less for the guidance of the worker as to method, since he is probably fully familiar with this, than it is for supervisors who may be checking up on the job from time to time.

The L. C. Smith and Corona Typewriters, Inc., agrees to pay the rate per 100 pieces as stated on any *Instruction Card,* only on condition that the method followed by the operator is in accordance with the conditions and instructions specified on the *Instruction Card,* and, The L. C. Smith and Corona Typewriters, Inc. also agrees to make no reduction in the rate of wage payment as long as the given operation conditions, instructions for operator, class of labor required and quality of work specified, remain in effect.

Supervisors and Assistants are instructed to cancel Piece Rate payments on all Job Cost tickets whereon the conditions, the method followed by the operator, or the class of labor assigned to the work is not in accordance with that specified on the *Instruction Card* or where the quality of work turned out by the operator does not equal the acceptable standard. Both Supervisors and Assistants are held strictly responsible for the enforcement of the above ruling.

The Management recognizes that there may be methods that are better or more economical than those contained in the *Instruction Card* and employees are requested to send any suggestions that they may have for betterment to the Planning Department, where they will be given full consideration.

FIG. 130. Rate Guarantee.

The worker as an aid in checking time studies. To place full information concerning the methods of computing the standard time upon the instruction card is one of the best self-imposed checks that a time-study department can possibly place upon itself. If this department is disposed to be unfair to the workmen it becomes more difficult to be so when the computations of standard time are subject to the inspection of the worker. On the other hand, giving the worker a copy of the time-study results indicates to him that the time-study man was "square."

Such procedure absolutely precludes the practice, which has been followed in some plants, of arbitrarily reducing standard time in order to overspeed workmen. This action must be coupled with the idea that the workman may call attention to selected element times which he feels are unjust and unreachable. If it were always possible to use only the one workman who was time-studied for the particular job all this precaution would be unnecessary, but since this is impossible every precaution is necessary to insure full and hearty response from each workman.

There is frequently a complaint made by some operator that he is unable to reach the standard of performance that has been called for on the instruction card. This may be due to one of the following causes or a combination of several of them: lack of skill on the part of the operator, trouble with his machine or equipment, delays which may have passed unobserved on the part of the time-study observer because they did not happen to occur while the study was being taken, or an incorrect time study. If an operator seems to be unable to make his standard time with any degree of regularity, and it is clearly not his fault on the face of conditions, it is essential that a new study be made to check the time study that has been taken, so that it may be finally determined whether or not the task time that has been set is a fair one.

Production studies. The new study that is made has been termed by some time-study men a "production study." It usually consists of the observation of the operator during an entire day's time, or such part of the day as he is working on the operation concerning which he has made complaint.

During the observation of the worker in this "production study" a careful record is made of all times consumed, including a record of the element times in the same way that these were recorded when the time study was originally taken. The particular value of this type of study is twofold: an opportunity is given to check the operation at another time and therefore to see whether the delays that occur are practically the same and are caused in the same way as those noticed when the study was originally taken; and second, an opportunity is given to see the effect of fatigue upon the worker, inasmuch as the study covers an entire day, which is an unusual length of time for an ordinary time study. A production study is, therefore, quite as much a fatigue study as it is a job study, and in reality consists of a combination of the two. It may conceivably happen that a time study which was accurate for jobs when they lasted only for several hours will prove to be absolutely incorrect for the same jobs when they are carried on throughout an entire day, because of the cumulative fatigue caused by carrying on the job for that length of time.

In order to insure accuracy in a production study, it is necessary that the element times be checked against the selected element times of the original time study. The observer will usually do this, to some extent,

214-7586-30M-4-21

INSTRUCTION CARD FOR METHOD OF OPERATION

L C SMITH AND CORONA TYPEWRITERS, INC

Date Issued 8 - 23 - 19 DRILLING Dept's copy Part No 2X92

Operation No. 4 Name DRILL ALL HOLES.

Time allowed at 100% efficiency for 100 pieces 2.39 Hours Rate paid for 100 pieces $ 1.278

Output required at 100% efficiency 41.75 pieces per hour Earnings at 100% efficiency $ .533 per hour

Time allowed on route board for 1000 pieces at 80% efficiency 29.88 Hours

DETAIL OF METHOD OF OPERATION	100% TIME ALLOWED
OPERATOR WORKS SITTING DOWN.	
1. PICK UP ONE UNFINISHED PIECE FROM PAN ON TABLE, WITH LEFT HAND, PLACE IN JIG AND LOCK JIG.	.10
2. SLIDE JIG UNDER FIRST SPINDLE, DRILL TWO #40 HOLES IN TOP EDGE. TURN JIG ¼ OVER, DRILL ONE #40 HOLE THROUGH SIDE.	.33
3. SLIDE JIG UNDER SECOND SPINDLE, DRILL TWO #48 HOLES THROUGH SIDE. TURN JIG ¼ OVER, DRILL TWO #48 HOLES IN TOP EDGE. TURN JIG ¼ OVER, DRILL ONE #48 HOLE IN BOTTOM EDGE.	.53
4. TURN JIG ¼ OVER, SLIDE UNDER THIRD SPINDLE, DRILL TWO #9 HOLES.	.16
5. TURN JIG ¼ OVER, UNLOCK JIG, REMOVE FINISHED PIECE AND THROW IN PAN FOR FINISHED WORK ON TABLE.	.06
6. BLOW ALL CHIPS FROM JIG WITH COMPRESSED AIR.	.07
REST ALLOWANCE @ 5%	.0625
MACHINE AND TOOL DELAY ALLOWANCE @ 10%	.125
(NOTE - ALL SPINDLES ARE OPERATED WITH HAND LEVERS. KEEP A HEAVY FLOW OF LUBRICANT ON DRILLS. KEEP MACHINE TABLE FREE FROM CHIPS, SO JIG WILL SET SQUARELY. TEST DEPTH AND DIAMETER OF TWO HOLES AFTER EACH CHANGE OF #40 OR #48 DRILL)	
TOTAL TIME ALLOWED FOR ONE PIECES	1.4375 MIN

Inspection Instructions WALKING INSPECTOR:-SEE THAT ALL HOLES ARE DRILLED AND HOLES ARE CENTRAL IN STOCK. GAUGE LOCATION OF FULCRUM HOLE G543, ETC. GAUGE DIA. OF FULCRUM HOLE G1653, ETC. GAUGE LOCATION OF #40 DRILL HOLE G2520. GAUGE DIAMETERS OF #40 DRILL HOLE G.ST393: #48 DRILL HOLE G.ST233. GAUGE DEPTH OF #40 DRILL HOLE G1658 OR 1659: DEPTH OF #48 DRILL HOLE G1640 OR 1657.

NOTE—OPERATORS WILL NOT BE PAID FOR WORK REJECTED BY INSPECTORS ON ACCOUNT OF DEFECTIVE WORKMANSHIP

If Operation or instructions can not be performed as outlined or changes are required, notify the methods Division of the Planning Department immediately

Method Approved T. M. JONES. Methods Div Date 8 - 23 -

Rate and instructions approved B. R. BIGELOW. Instruction Div Date 8 - 23 -

Fig. 131a.

as he goes along, so that if there are any great discrepancies, he will be enabled to see the cause of these during the time that he is taking the second study. On the other hand, much of the result of the production

study can be secured only by working up the data at its conclusion. The charting of the times consumed during certain hours of the morning and the afternoon may give the necessary information concerning

MACHINE AND SET UP INSTRUCTIONS

Machines (on which job can run piece work) 040301-2-3-4-5-6. 040401-2-3-4.

Emergency machines (on which job can be run, but not on piece work) ANY OTHER DRILL PRESS, HOWEVER ALL ARE INCONVENIENT AND SHOULD BE USED ONLY AS A LAST RESORT.

Location of finished work IN PAN ON TABLE, LOCATED AT RIGHT OF OPERATOR.

Location of unfinished work " " " " " " LEFT " "

Condition in which work will come to job FAIRLY CLEAN AND FREE FROM CHIPS.

Material Kind COLD DRAWN STEEL. Thickness .162" Width .502" Grade SPECIAL

Number of machines run by operator ONE Lubricant used WATER COMPOUND How used PUMP-HEAVY FLOW.

Spindle #1 Speed 2040 R. P. M. Feed HAND P. M. Frequency of sharpening Tools AS NECESSARY - ALL DRILLS

" #2 " " " " " " WILL BE OBTAINED FROM TOOL CRIB, SHARP

" #3 " " " " " " AND READY FOR IMMEDIATE USE.

" - " - " " - " Tools located in tool Crib No. 3

All Tools, Equipment and gauges required (Give all Tool numbers) JIG 1125,2347,590-USE ANY ONE.

GAUGE 543,1637,1638,1571,1227,1639,2025,2026,2027,2028-USE ANY ONE.
GAUGE 1653,1654,1655 1656-USE ANY ONE. CHAIR FOR OPERATOR.
GAUGE 1658,1659-USE EITHER. DRILLS, #9 H.S.,#40 AND #48 CARBON.
GAUGE 1640,1657-USE EITHER. AIR CONNECTIONS.
GAUGE ST393. GAUGE 2520.
GAUGE ST233. DRILL SETTING GAUGE 2383,2384,2385,2386-USE ANY ONE.

INSTRUCTIONS FOR SET UP OF JOB

TOTAL TIME ALLOWED AT 100% EFFICIENCY - - - - HOURS RATE PAID PER HOUR AT 100% EFFICIENCY - - - - 100% TIME ALLOWED

#40 DRILL IN FIRST SPINDLE FROM LEFT HAND SIDE.
#48 DRILL IN SECOND SPINDLE FROM LEFT HAND SIDE.
#9 DRILL IN THIRD SPINDLE FROM LEFT HAND SIDE.

SET UP OTHERWISE NOT STANDARDIZED.
SUPERVISOR OR SET UP MAN WILL SEE THAT ALL TOOLS, GAUGES, PANS FOR FINISHED WORK, SUPPLY OF LUBRICANT AND OF UNFINISHED WORK ARE ON HAND: THAT SET UP IS CORRECTLY MADE AND WILL TURN OUT THE CORRECT STANDARD OF QUALITY, BEFORE AN OPERATOR IS ASSIGNED TO THE JOB.

TOTAL TIME ALLOWED

Note—Regular hourl rate will be paid for setting up emergency machines. Supervisors are responsible for the accuracy of all set ups and must approve samples of work from each set up, before set up Job will be considered completed.

FIG. 131b.

fatigue upon which to base recommendations of change in time allowed for the operation, or possibly on which to recommend relief from fatigue by means of rest periods.

INSTRUCTION SHEET

Cat. No.: 5300 Major Oper No. 1 (XO-1)
Major Operation Engrave (S-8 Plate & Std. 131)

Name: Test Set
Oper. Performed in Shop B
Job Rating Second class engraver

Work to be Performed in Operations as Listed Below

Oper. No.	Detailed Instructions	Tools Required	Average Time Work Should Take	Time Allowed	Time for Lot of
1	First set up for engraving machine. Set up machine to engrave 20 characters on upper half of plate	Engraving master, fixture for holding plate and arrow gauge for S-2 and S-15 units		30 min	30 min.
2	Engrave 20 characters as per above set up. Check location of arrows using gauge.		6 5 min	7 2 min	3 hr.
3	Second set up for engraving machine Set up machine to engrave 18 characters on lower half of plate.	Engraving master, fixture for holding plate and arrow gauge for S-2 and S-15 units		15 min	15 min
4	Engrave 18 characters as per set up #2. Check location of arrows using gauge.		5 5 min	6 min	2 hr 30 min.
5	Third set up for engraving machine: Set up machine to engrave serial numbers.	Engraving masters for serial and fixture for holding plate		20 min	20 min
6	Engrave serial (6 figures) as per set up #3.		3 1 min	3 4 min	1 hr 25 min
7	Fourth set up for engraving machine Set up machine to engrave arrow on Std. 131	Engraving master and fixture for holding arrow.		15 min	15 min
8	Engrave arrow on Std. 131 as per above set up		7 min.	8 min	20 min
9	Take plates and Std. 131 to inspector, put away tools and change time slip.			15 min	15 min

Total Time to Engrave 25 *Sets* (Second class engraver)

Total set up time .	1 hr 52 min.
Total productive time ..	7 hr. 45 min.
Total.	9 hr 37 min.
Supervision .	.3 hr.

Fixed time	1 87 hrs
Productive time per 100	31 hrs.

Set up time and productive time have 10% unavoidable delay and 8% time out allowances added.

Any change in amt to order, material, design or conditions which affect the above time standards, should be reported to the Shop Eng Dept, at once, so that necessary corrections can be made.

Made Up 8-21-39 By S. Kent
Approved 8-27-39 By R.M.

LEEDS & NORTHRUP CO.
PHILADELPHIA, PA.

FIG. 132.

Often interesting data will be obtained from the production study which will in short order direct the attention of the observer to the causes of the workman's inability to make his standard time. For instance, if it should be found that the elements which were entirely handling time were being performed well within the selected element time, while the elements which were entirely machine time were running uniformly larger than the selected time, it would quickly indicate that there was something wrong with the equipment or the method by which it was being used. At any rate the production study will clearly reveal whether the particular operator is unable to reach the time that has been set because of the conditions of the time or the conditions of the job, including himself. It may reveal the fact that he is leaving his machine more frequently than is necessary, that he lacks skill, or that the handling time and the time for the adjustment of the machine are unduly large, or it may reveal the poor condition of the equipment, in case that be the difficulty.

Studies of automatic machinery. Production studies deal primarily with delays and their causes, whereas time studies ordinarily deal with the proper times for performing elements of operations, and although they are concerned with delays, these are merely incidental. One class of time study in its original form is similar to a production study. This includes all time studies on automatic machinery. Automatic machinery, when once started, is supposed to continue in operation until the supply of raw material which is fed into the machine is exhausted. On many such machines provision is made for the continuous supply of material, so that there is supposedly no cause for the stoppage of this machinery during working hours. It would seem futile to take time studies on this type of machinery or operations involving its use. As a matter of fact, such operations are among those of which it is most profitable to take time studies, and where the results achieved in proportion to the energy expended are likely to be large. In taking time studies of this type of job, the study takes the form of finding out the causes for delay rather than what the time of various elements should be. The times for the elements are involved in the continuous operation of the machine, which is also an important field of study for a methods department, but does not necessarily involve time study.

It is impossible to operate automatic presses, screw-cutting machines, looms, or any other type of automatic machinery without interruptions; but a study of interruptions determines whether the worker or the machine is the cause of failure to reach the set task. Small automatic screw-machine shops have often proved a source of large profit to their owners on a small investment. On the other hand, similar shops have proved to be white elephants on the hands of other owners. The dif-

ference lies largely in whether or not the machines have been kept producing throughout the working day. In all automatic machinery, tools become dull or require changing, the material supply may run low, or there may be a number of other causes for stoppages. A time study of such machinery involves taking a production study for a period of a day or more, to determine which of these stoppages are avoidable and which are unavoidable. When this information is at hand it is possible to set a rate of stoppages which will apply to that machine at all times when working on the class of work studied. This will enable the shop to set standard times on the automatic machines which will be entirely within reach, in the same way that they may be set on any other machines in the shop. The setting of the standard time merely involves taking the capacity of the machine and deducting the allowances which have been found by the production study to be necessary.

Selling time and motion study to the workers. It is by no means a simple task to convince workers that their interests are being served when time and motion studies make possible increased production. This situation is particularly difficult during periods of depression when many men are already out of work. An unwise move on the part of management during such times frequently precipitates conflicts that are more devastating than the inefficiencies corrected. One of the best methods of introducing time study in a plant that has never used it is by the "conference method." The program literally has to be sold both to the foremen and to the workers. A class in time and motion study in which both the foremen and the representatives of the workers seriously study the objectives and techniques of time and motion study will prepare them both for its use. It will be necessary for absolute honesty to prevail. It is not a program for getting something more in the form of increased production at the expense of the workers.

Time and motion study objectives should be clearly set forth; namely,

1. To find the one best method of performing a task with due regard to the fatigue of the worker. The best method should be the easiest method.
2. To provide accurate information as an aid in planning.
3. To serve as a basis for setting an equitable wage.

Management should recognize that the worker expects to share in the benefits of increased production. When standard times are once set they should be rigidly adhered to unless conditions change fundamentally. A broken promise is long remembered. Full cooperation from workers cannot be expected unless a reputation for "square dealing" prevails.

CHAPTER XXXIII

WAGE SYSTEMS NOT BASED ON TIME STUDY

Wage-payment systems will be discussed here from the standpoint of management, that is, securing the greatest possible production from the worker compatible with his health and fullest co-operation. There is no necessary conflict between this viewpoint and that of treating the subject from the standpoint of the worker or the community welfare. Factually in the long run their interests are mutual. If we should approach the wage discussion from another angle than management our emphasis would be somewhat different but the results would inevitably be the same.

In considering these wage-payment systems it will always be well to keep in mind the requirements of the cost-accounting department of the business as well as of the production and general management forces. Systems which involve the collection of a multiplicity of data may conceivably succeed in increasing output and thus decreasing the unit cost of production, but fail because of the excessive cost and difficulty of collecting data for payroll and cost purposes.

Time basis—the day rate. The payment of a certain amount to a worker for a certain period of time is usually known as a "day rate," whether the period of time be a day, a week, or an hour. The day rate is perhaps the oldest method of wage payment under our present industrial system, and a large proportion of the industrial workers of the United States are today being paid under some form of the day rate. Unless the worker be so inefficient as to merit discharge, or unless he be so expert as to be raised into a higher wage classification, it is unlikely that his individual rate will be changed. Thus the amount or quality of work which he does has little bearing on the wage which he receives, except over long periods of time. There is, under this system of payment, little to urge a worker toward greater production except loyalty to his task or some spurring action on the part of his employer or his direct superior.

Many workers have favored the day rate, because under it they could definitely determine in advance what their wages would be. That all workers of a given class generally receive the same pay constitutes

no objection for some workers. In fact they tend to favor it, because it implies a unity of action, through organization, of all members of the wage group, in case it seems possible to secure an increase in the rate. For these reasons, day rates, once raised, are frequently as difficult to lower as any other kind[1]

In the main, labor unions have tended to favor the day-rate system. Unions exist for the benefit of their membership as a whole, and therefore anything which will tend to increase the unity of purpose of their members is likely to enlist their support. The day rate is a perpetual influence toward solidarity in the union. Substandard workers look to it as a means of raising their wages far beyond anything they could expect under piece rates. The average worker is likely to be satisfied with the prevailing wage. The best workers are likely to be striving constantly to increase their incomes, and in doing so will tend to increase, along with their own incomes, that of the other members of the labor organization. As a matter of fact, the best workers who, under other systems of payment, are least likely to be interested in unions, under the day rate are likely to be the prime movers toward organization. It is their only hope for increased wages. Thus they frequently begin to combat the management, whereas under other circumstances they may be made the management's greatest supporters among the workers.

It must not be inferred that all trade or industrial unions oppose piece rates or other wage programs based on output per worker. The men's garment workers in Chicago have been for more than twenty-five years operating on some form of incentive wage payment which pays for productivity per worker. This is one of the most highly organized and disciplined groups in the trade union movement.

Quality of product should be enhanced through the day rate. The workman, not being rushed, should be able to utilize fully his talent in those tasks where such expression is possible. Plants or departments in which quality is a paramount consideration are thus most likely to be on day rates. Nevertheless, effective foremanship and newer methods of wage payment make possible high-quality production without the day rate.

Payroll department operation is made simple by the day rate. The payroll may be prepared directly from the attendance time cards. On the other hand, *cost-department operation is made more difficult.* Production will vary greatly from man to man and from day to day under this system, and wages thus become a variable element of cost which

[1] The student should keep in mind that day rate as used here refers to the system without accurate standards being set It is possible to have a system of time payments based on job study with carefully set standards of performance. The objection cited above does not hold under such measured performance.

cannot be predetermined. Thus, it becomes difficult to plan production-cost budgets and to set selling prices.

Regardless of the type of wage-payment system that may be in vogue, it is usually necessary to pay a certain percentage of the workmen by the day rate. This group of workmen will include not only supervisors, but any men whose work is so diversified, incapable of standardization, or temporary, as to make it impossible to work out a satisfactory wage under any other system of payment. Because of its ease of operation the day rate will probably continue to be much used as a system of wage payment.

The system of payment according to the day rate includes payment by the hour. For instance, the worker may be employed by the hour as the time unit rather than the day. In this case his earnings are computed as follows: $E = RN$, in which R signifies the rate per hour and N the number of hours worked. This usage of the term day rate is a misnomer but has become quite general.

How 133 plants look at wage incentives. One of the most recent surveys of the status of wage plans was made by Mr. L. C. Morrow, Editor of *Factory Management and Maintenance*. The 133 plants involved represented practically all types of manufacturing. The following table gives the distribution of the different systems with the extent of their use.

TABLE 10

USE OF INCENTIVE SYSTEMS *

(133 Plants)

Incentive System	Per Cent of Plants Using to Some Extent	Average Per Cent of Employees Being Paid by This Method	Range in Actual Per Cent
Straight Piecework....	45 86	47 40	½ to 100
Individual Bonus. . .	45 86	46.30	½ to 100
Group Bonus... ...	34 60	28.66	1 to 100
Measured Daywork .. .	6 80	52 33	2 to 100
Straight Daywork... . .	86 47	45.11	3 to 100

* Source: *Factory Management and Maintenance*, Vol. 95, No. 10, p. 75.

In answer to the question, "Is your use of incentive payment increasing, decreasing or stationary?" the replies showed conclusively that the plants using incentive plans were not contemplating discarding it or materially reducing its use.

The straight piece rate without job study. The second of the older plans of paying workers is to fix a price for the completion of a given task, and pay that price without reference to the time taken in completing the task. This statement merely means that time is not considered in figuring the worker's earnings after the piece rate is established. Naturally the time element was originally considered in the establishing of the piece rate itself. As a matter of fact *time is a basic element in the formulation of any wage scheme* regardless of the method of computation after the wage plan is established. In straight piece rate without job study the task may be either the completion of one unit or of a given amount of work, and the rate is ordinarily termed a piece rate. Piece rates have been set usually with strict regard to previous day-rate earnings and previous performance. They have usually been determined by dividing the day rate by the average units of production, in order to secure the proper rate per unit. Frequently the rate has been made somewhat less than this amount, under the assumption that production will increase under piece rates and that this will bring greater profits to the employer. In the early days the employer was willing, at the start, to profit only through the reduction in his fixed overhead expenses per unit of product.

First-class workers handling repetitive work have usually been anxious to be placed upon piecework, inasmuch as it gives them an opportunity to realize on their accumulated skill and knowledge of the job. The direct monetary gain which results from study of the method of performing the job by the worker is likely to result in a keen study by him of the conditions which surround it. Within limits, he becomes receptive to improvements in methods promulgated by the management. He is not receptive to such improvements when he is fearful that they will be so marked as to result in cutting the rate. Substandard workers and those working on diversified work on which the setting of piece rates based on past performance is difficult are not likely to favor piece rates.

Rate-cutting. The greatest defect in the piece rate in practice is one that in theory need not exist. That is the tendency toward rate-cutting. Although the employer is receiving benefits in reduced overhead charges, he is not likely to allow workers to continue for any great length of time to "kill" a job, that is, to get wages which are far in excess of the usual rate of wages for such work. Either the press of competition, or the desire for increased profits, or both, is likely to cause the employer to demand that the management cut the rates. Frequently this has been done under the assumption that if the workers do not like the change they can readily be replaced at the new rates. The action of rate-cutting is equivalent to informing the employees that there is a maximum of earnings beyond which workers of any general class will

not be permitted to go. Such action, once taken in an organization, or fear of such action based on practices in other organizations, causes workers to hold their production under piece rates at the easily reachable figure which it is thought the employer has set as his maximum. If rates have once been cut, this figure will at times, through a shop, be so uniform as to amount almost to an exact limit.

Really radical changes in production method, which so change the job as to make the past rate absurd, have been frequently looked upon by workers merely as *an excuse for cutting rates*. Changes in method have at times been bitterly fought by workers for fear that under the new method and new rate they would be unable to make as high piece-rate earnings as under the old method. This confusion between logical piece rate readjustments and rate-cutting results in numerous borderline cases which it is difficult to settle amicably, because there are no real data, convincing to both sides, which may be used as a basis.

If straight piece rates are used, it is essential that some provision be made for the learner. Inasmuch as there is no day rate guaranteed under straight piece-rate plans, it is necessary that a special "learner's rate" be established, which is usually on the day-rate basis. The length of time that the learner remains on day work varies with the type of operation and with the factory, as well as with the training system that the plant has installed. The learner's rate usually starts at a low point and gradually increases up to the point at which the worker is put on piece rate. Another method of providing for the learner is to pay a flat day rate such as fifty cents per hour for a short period and then reduce the day rate during successive periods, allowing the learner the lowered day rate plus his earnings on pieces completed at the regular piece rate. Such a program provides a strong incentive for the learner to make a special effort to increase his speed of learning. In the absence of some such sliding day-rate scale it is not at all infrequent that a beginner will work the full learning period on the day rate and then refuse to go on piece-work, giving as his reason that he cannot make out on piecework.

Piece rates have the disadvantage of being somewhat inflexible. Difficulty in the setting of piece rates is encountered when the whole level of rates paid workers rises and falls. If rates have been raised during periods of high wages, they are usually decreased during periods of depression and falling wages. Such lowering of wages is, of course, a cutting of the piece rate. This situation results in very perplexing problems which have been solved by some plants not by increasing piece rates, but rather by giving a "cost of living" bonus, or by placing the wages from an increased piece rate in a separate pay envelope, in case the rates were increased.

In times of depression, when orders are scarce, the piece rate has a

great advantage over day rates or any of the newer systems which guarantee minimum earnings to the worker. Under such conditions many plants are operating from hand to mouth on orders and this is as well known to the workers as to the management. The piece rate does not invite the worker to stretch available work, so as to insure himself a job under such conditions. In prosperous times, with orders plentiful, this ceases to be an advantage of the piece rate.

From the cost-accounting and cost-estimating standpoints, piece rates are far better than day rates, but not ideal, as contrasted with other systems. The direct labor cost per unit of product or per job becomes a fixed amount which may be accurately determined in advance. But, since the time of doing the work varies considerably, the amount of overhead expense which will have to be distributed to an operation or an order is an unknown quantity previous to actual performance. This same criticism holds with equal force with respect to most of the other incentive plans.

The computations of earnings on the piece-rate system are very simple. Expressed in terms of a formula, earnings = the number of pieces × rate per piece, or $E = NR$. On the assumption that the rate per piece is 10¢ and the worker completes 48 pieces in a given day his earnings would be: 48 × 10¢ = $4.80.

Incentive wage systems. In meeting the objections to the older systems of wage payment and developing methods which will prove to be lasting improvements, attention must be paid not only to proper remuneration of the workers, but also to proper remuneration of invested capital. Schemes can be devised which will prove entirely satisfactory to the worker but which will in time be eliminated by those controlling the enterprise because they will not be flexible enough to permit the meeting of increasing sales competition. Thus any wage scheme which gives the worker a percentage of the savings incident to increased production and yet prohibits innovations in manufacturing method or merely inclines to make the worker peg his production at a somewhat higher point than formerly, due to fear of ultimate wage-cutting, will not be beneficial for long. Rival plants, whose rates are set on the basis of newer manufacturing methods, or whose workers have not pegged production even at the relatively high level, will always be able to underbid, because of lower manufacturing costs. This is the basic reason behind changes of rates when the process or operation is changed. It is thus essential that any wage-payment system which is devised shall so arrange the remuneration that the permanent co-operation of both the workers and the stockholders' representatives shall be assured.

In general, it may be definitely stated that unorganized workers like to work under one of the "incentive" wage systems when they are fully

convinced of the fairness of the management and the fullness of information possessed by the actual rate-setters, as well as the competence of the latter. These systems plainly indicate to the workers that they are expected to perform up to their capacity, fatigue considered, while they are on duty in the factory. *Incentive wage systems awaken the interest and put the spirit of competition into industry.* They make it practical to arouse interest in work to an extent that can be achieved in no other way.

An incentive wage, in order to be effective, *must generously reward the worker for the additional application, following of instructions, increase in output, and quality of workmanship which is required in order that the additional wage shall be earned.* Unless the reward for increased production is large enough the worker will not be stimulated to the increased production which is possible under such a wage system. In Taylor's experiments he found that increased effort on the part of certain classes of workers could be stimulated only by paying incentives above the base rate as follows: [2]

Machine shop workers doing general work	30%
Laborers performing work calling for severe bodily exertion	50–60
Machinists doing delicate and difficult work	70–80
Machinists performing work requiring close application, strength, skill, and brains	100

It should be emphasized that cupidity on the part of management is like signing the death warrant of any of these incentive schemes of wage payment. If the reward is large enough the worker will be enabled to take new pride in his work, the pride of having earned more money this week than he did last, because he worked better and more effectively. The pride of accomplishment in relation to his fellow-worker develops. This is a perfectly logical and justifiable pride and does not necessarily result in the setting of a killing pace.

The meaning of symbols used in wage formulas. In our further discussions of wage plans we shall make frequent use of formulas to express the methods of computation. It will facilitate their use to have clearly in mind the meaning of the symbols used. The formula for computing earnings for piece rate was given as follows: $E=NR$. E represents the earnings per day or period, R signifies rate per piece, and N stands for the number of pieces produced. R is used in other wage plans to indicate the rate per day or whatever unit that is used as a basis for payment. Other symbols that will be used are as follows:

[2] See Frederick W. Taylor, *Shop Management*, Harper and Bros., New York, 1919, p. 26.

S = standard or allowed time for completing a particular task. To illustrate, if the standard for a given piece of work be 10 minutes and a worker completes 6 pieces his S, standard or allowed time would be one hour even though the actual time worked may have been 50 minutes or even 70 minutes.

T = actual time spent in performing a given task.

p = premium percentage.

Premium plans—the Halsey Premium System. All premium plans of wage payment aim to give the worker some share of the saving in the costs of production which are earned by turning out the work in better time than the task, standard, or normal time for the job. One of the most common of these systems is the Halsey Premium Plan, named after F. A. Halsey, who devised it at the time he was superintendent of the Rand Drill Co., of Sherbrooke, Canada. The basic idea of it is to set a standard time, usually by ascertaining the average previous time of doing the job, and to offer the workman an agreed percentage of the wages of any portion of this time that he may save, in addition to his hourly or daily rate for the time consumed on the job.

Although, as originally conceived and generally used, the standard time under this plan was the standard of past performance in the shop, there is no reason why a standard time determined from time study cannot be used under the Halsey plan. However, *since the Halsey plan gives the worker only a portion of his saving, if time study be used as the basis, it is essential to set the standard time somewhat higher than the time which can be made, in order to provide sufficient incentive for the worker.* The task time set by job study thereby becomes a base for the management to work from rather than a task to be reached. However, under the Halsey plan, the standard time is usually the average of previously recorded times. It is usual to guarantee that when the time is once set for a job it will not be reduced, despite the fact that conditions may not have been standardized, or the jobs studied. The system is *liberal with the time allowance rather than with the premium percentage.*

Day rates are *guaranteed* under this plan, and to men who finish their tasks in less than the allotted time there is paid, in addition to this base day rate, a proportion ranging from one-quarter to one-half of the wages of the time saved. Thus the wage under the Halsey system is equal to the time taken times the hourly rate, plus the time saved times some fraction of the hourly rate.

$$E = TR + (S - T)\frac{R}{2}$$

The formula given above is for an allowance of 50 per cent of the hourly rate. The fraction of the hourly rate that is most generally used is about $33\frac{1}{3}$ per cent, in case conditions have not been standardized or the job studied. If the job has been studied, the fraction of the hourly rate that is used will ordinarily range around 50 per cent. The percentage of the time saved—from 30 to 50 per cent—is likely to represent a rather large part of the total wage, and to make the percentage larger would be apt to create a distinct temptation to the employer to reduce the standard time when shown that it was considerably longer than actually necessary. The emphasis in this method is on sharing the time saved between the employer and the employee, as in this formula on the basis of 50-50. Any other ratio can be used but it seldom exceeds 50 per cent.

Another method of expressing the formula for computing the earnings is as follows:

$$E = TR + p(S - T)\,R$$

To illustrate the working of this plan, we may consider the case of a workman who is on an hourly rate of 50 cents per hour, and has an eight-hour task given to him, which he completes in six hours, working with a bonus of 50 per cent of the time saved. He will receive:

$$6 \times \$0.50 + \frac{(8-6)}{2} \times \$0.50 = \$3.00 + \$0.50 = \$3.50$$

It will be noted that he received \$3 50 per six hours' work, which is at the rate of $58\frac{1}{3}$ cents per hour, or at the rate of $\$4.66\frac{2}{3}$ per day, provided his time on the next job, which he may start immediately, is as good as the time on this job.

The Halsey plan is easy to introduce. It is not absolutely necessary that there be preliminary studies, other than those which will determine previous times on the jobs, and the plan is therefore excellent in any shop as a sort of transition plan to be used while studies of the jobs in the shops are being made and to arouse the interest of the workmen in incentive wage systems. This plan, in a slightly modified form, received its greatest amount of advertising from its use in the shops of the Yale and Towne Manufacturing Company. It was used as a transition plan in this case, since it has been largely supplanted by other incentive wage systems.

One of the chief merits that is urged for the Halsey plan is that it makes for the permanence of the rate because of the method of division of the profit on saved time between the employer and employee. If an extremely large amount of time is allowed for one job, and as a result the workman makes a very great saving of time, only a portion of the

saving is given to the workman; this prevents the employer from having an immediate desire to reduce the rate.

Since premium earnings often total a very large percentage of the total wages, the plan is criticized from the management point of view in that standard times prove in practice to be so very high that a temptation to reduce standard time in one way or another is sure to come eventually. And further, standard times are sure to be uneven in that some will be very high and some will be comparatively low, resulting in an unjust payment plan with "fat" jobs and "lean" jobs. In such cases there will tend to grow up a picking and choosing of jobs among the workmen, or criticism of the allotment of jobs among them, just as in any piece-rate plan where the piece rates are variable in their earning capacity. Furthermore, the workmen can beat the game by spurting on certain jobs to earn a premium, and "soldiering" on other jobs to rest up under the guarantee of day wages. This entire difficulty can be overcome by using time study instead of past experience as a basis for rate setting. However, it should be borne in mind that originally the Halsey Premium Plan was not based on time study; neither has it been used extensively in practice.

The Rowan Premium Plan. Another typical premium plan, which has received much attention, originated in a Scotch establishment, David Rowan and Sons of Glasgow, being developed by Mr. James Rowan of that firm. It is used more extensively in Great Britain than in this country, though several large American concerns, notably the Packard Motor Car Company, have at times used it in parts of their factories. Although a premium plan, like the Halsey, it differs in the method of computing the premium and in the base used. Wages, instead of being increased by an arbitrary percentage, applicable to all similar jobs, are increased by a percentage equal to the percentage of reduction which the worker has made on the standard time of the particular job. This premium is a percentage of time worked, rather than of time saved. The day rate is guaranteed.

$$E = TR + \left(\frac{S - T}{S}\right) RT$$

If a worker finished 36 pieces in an eight-hour day while working on a job, whose standard was 32 pieces per eight-hour day, his earnings at a 50¢ per hour base rate would be as follows:

$$8 \times \$0.50 + \left(\frac{9 - 8}{9}\right) \times 8 \times \$0.50 =$$

$$4.00 + 1/9 \text{ of } \$4.00 = \$4.444$$

From the formula given above it is apparent that the premium under the Rowan plan can never quite equal the day rate, for the value of the fraction $\frac{S - T}{S}$ constantly approaches unity as the actual time T approaches zero Under the Halsey plan daily earnings can be greater than twice the day rate, but this is impossible in the case of the Rowan plan. Ordinarily the premium is larger under the Rowan plan than under the Halsey plan. If the Halsey premium be 33⅓ per cent, the Rowan premium will always be larger up to 66⅔ per cent of time saved. If the Halsey premium be 50 per cent, the Rowan premium will be larger up to 50 per cent of time saved.

Although it is somewhat easier to justify the percentages used under the Rowan plan than those under the Halsey plan, nevertheless adaptations of the Rowan plan are far less widely used, chiefly because the method of figuring wages is too difficult, and the worker finds it hard to understand, and harder to know what he has earned at any given time. It involves the use of a large clerical force for payroll purposes. As the use of standard costs (described in Chapter XXXVIII) spreads, the use of such premium plans as the Halsey and Rowan must necessarily decrease, because cost predetermination is almost impossible.

CHAPTER XXXIV

WAGE SYSTEMS BASED ON TIME STUDY

Incentive wage systems which are developed to have workers make a set task rather than to excel a set task are best suited to the demands of modern managerial controls. Budgeting, standard costs, and the control of the several phases of a business all are assisted if the approximate time required to perform tasks can be predetermined. Therefore, wage systems that are constructed on past performance which it is expected that the workers will exceed are no aid to other phases of management. Wage systems based on accurately predetermined tasks urge the worker toward performance in the standard time which serves as the basis for production controls.

Piece rates and the premium systems without job study permit drift in management methods. Wage systems based on job study prohibit management from drifting, because standard conditions are a preliminary step to the development of all such systems. When the task has been accurately set on the basis of fair time for the job, the worker must receive all the advantage which he gains by the reduction of working time below task time. Therefore, these systems push the management quite as much as the management pushes the worker. It should be remembered that job study may be used as a basis for setting a given task and yet set the task deliberately below what is known to be easily attainable by the average man. This is done when it is desired to build a wage program in such a manner that the bonus becomes a relatively large part of the daily earnings of the average man in certain programs. Such programs frequently share with management the time saved.

The higher rates which the workmen earn under all of these systems must necessarily take into account the fact that the management, as well as the worker, has had a hand in the increased production which is being secured. The employer has given more of his thought and money for the installation of the new conditions under the operation of these wage systems than in the operation of the premium systems previously discussed. The employee, on the other hand, must give somewhat more concentration and possibly lose some of the pleasure which may be presumed to come from freedom to do the task in his own way.

Straight piece rates based on job study. Piece rates based on job study form the simplest incentive wage and generally a very effective one. Piece rates so set readily can be guaranteed by the management, provided provision for change in rate, if the operation be changed, is made. Piece rates thus set become an incentive wage because the worker realizes that there is no possible cause for him to peg his production at any point. In order that such rates actually may be an incentive wage it is essential that, after turning out the increased production made possible by the job studies, the worker's wage be appreciably higher than his previous wage or the prevailing community wage. The piece-rate earnings are easy to compute both by the time office and the worker. The formula is:

$$E = NR$$

Piece rates based on job study with a guaranteed minimum wage. The satisfactory administration of the straight piece-rate system requires that if, for any reason not within his control, the worker is placed on a new job, one with which he is unfamiliar, or one on which, for any other reason, through no fault of his, he cannot make his high rate, he should immediately be placed on a guaranteed day wage. This rate may best be the average of his piece-rate earnings over a definite, previously determined period. Such a modification of the straight piece-rate payment plan based upon time study eliminates one of the criticisms of piece work from the worker's point of view. This plan somewhat complicates the problem of the budget director and cost accountant, but its evident fairness to the worker and tendency to reduce friction between management and the men counteracts the disadvantage in cost determination. Sometimes the guaranteed minimum corresponds to what would normally be a day rate when the failure of the worker to make his piece rate is caused by a shortage of material, machine break down and similar items. The payment of the predetermined average earnings over a recent period usually applies when the worker is transferred to a new job for the convenience of management as indicated above. The payment of a guaranteed minimum rate to the worker places the desired share of responsibility on the supervisors. Day rates are frequently used for piece-rate workers when starting new jobs such as new models in the automobile industry.

Day rates based on production. These are of two types: (1) a series of day rates based on productiveness, or (2) one high day rate based on a high standard of performance. The utilization of a series of day rates based on performance provides for a number of classes of operators for any given task. These classes have their limits, fixed by the production of the workers in them. As the productiveness of an operator increases or decreases, he moves from one of these classes to another, and conse-

quently has his rate changed If records have been accumulated, covering the performance of a number of workmen, it will soon be found that the workers will divide themselves into fairly well-defined classes which can have different rates of pay assigned to them. It is unnecessary that the individual worker be working always on the same job or type of job to utilize this system. In case a record of the individual productive efficiency of each worker is kept on whatever task he may be working and then all the workers are divided into distinct wage groups, based on their general efficiency, rather than their efficiency on any one particular task, this system may be used on all jobs. Under a scheme of this sort, advances or decreases in the worker's rate may be made at intervals of one month or three months, or at any other period that is deemed best by the firm.

The second type of day rate based on production provides for day rates for jobs rather than for workers. Each job has a day rate assigned to it, which is far larger than the worker can earn by the ordinary day or piece rates that have been in force in the factory up to this time. At the same time that this high day rate is placed on the job, a standard is set for that job. If the worker makes the standard or better, he receives the high day rate. If he fails to make the standard, he drops back to the old day rate or piece rate of the job, or a new piece rate figured out in such a way as to make the worker suffer a loss in his pay envelope due to his failure to make the standard. Usually, for the most effective operation of this type of wage-payment system, it is necessary that the worker's performance be figured over relatively long periods of time, and that he be not deprived of the high day rate merely for failure to make the standard over a comparatively short time.

This system has the advantage of ease in the computation of the payroll that is to be found in the day-rate scheme, and at the same time it enforces high production. It is very useful in plants where the workers object to working on piece rate, and where, therefore, the penalty of failing to meet the standard will not only reduce their wage, but will serve to place them under a wage system that they do not like. If the system is fairly devised it is usually easy to secure the co-operation of the worker.

In style industries in which new rates must be set constantly, the use of day rates based on production is much more simple than any other form of wage payment. Since a worker has had a day rate assigned to him, based on past performance, on short jobs that have not been time-studied, and which it may be unprofitable to time study, he may be given the day rate which he has had previously. He may also be kept on this same day rate while production standards are being worked out for new jobs on which standards ultimately may be set.

Measured day work. Recent management literature has been featuring discussions of a special type of day rate which its sponsors have named "measured day work." [1] This program is in part an outgrowth of management's attempt to meet or anticipate labor's demands following the passage of Section 7a of the National Industrial Recovery Act, and more recently the National Labor Relations Act. It is also an outgrowth of an attempt to recognize other factors than production in a wage program and still retain many of the advantages of the incentive plans.

The new program of "measured day work" establishes standards of performance by careful time study and sets a basic hourly wage for each job classification. In addition to the base rate for each job classification each employee receives added inducements based upon his dependability, versatility, quality output, and productivity. Length of service and other factors may be included if desired. The base rate for the job classification remains constant as long as the method and the conditions of the work or the general wage level remain unchanged. The added inducement which is a part of the individual's wage may change from period to period depending upon the worker's actual performance over the past period evaluated. The length of this period may be one month at the beginning of such a wage program but is usually increased to three months after the system is thoroughly established. Careful records must be kept of the worker's attendance, quality of work, productivity, etc, to enable the foreman periodically to evaluate his relative worth to the company.

In establishing the base rates for the jobs each one is carefully evaluated in terms of such factors as:

1. Mentality required to perform the work.
2. Skill required of the worker.
3. Responsibility for material and equipment.
4. Physical application and energy required.
5. Mental concentration required.
6. Working conditions.

Absolute uniformity does not exist by any means in the factors included in the job evaluation. Kimberly-Clark Corporation does not consider working conditions unless two jobs are rated exactly the same, in which case working conditions are considered to see if one should be rated above the other.[2]

[1] See William R. Howell, "Measured Day Work vs. Wage Incentives" in *The Society for the Advancement of Management Journal,* Vol. III, No. 1, Jan. 1938, pp. 54-57; also R. H. Rositzke, "Measured Day Work" in *Factory Management and Maintenance,* Vol. 95, No. 2, Feb. 1937, pp. 45-46.

[2] See American Management Association, *Compensating Plans for Executives and Workers,* Personnel Series No. 30, pp. 8-16.

Measured day work tends to level out the worker's earnings over most incentive plans, particularly during periods of introducing new models or closing out old ones. In some instances the worker is paid on a weekly basis. This system places an additional burden upon supervisors to keep production per worker up to task, however, this problem is not so great where workers are paced by a conveyor. It does, however, become a real problem where the assembly line is not used. Clerical work for payroll purposes is much less than for many of the incentive plans, but the work necessary to collect the data needed for periodically evaluating the individual's addition to his base rate brings the clerical detail up to approximately the same level as most incentive plans. Workers will not complain when their ratings are being raised but friction can easily arise when an individual's rating is lowered It is wise to have the aid of others than the foreman in rating the workers to avoid prejudice.

Measured day rates eliminate complaints from the workers about shortages in their pay which are frequent occurrences in incentive programs. A criticism of measured day work is the fact that the basis is shifted from "an engineer's job standardization to a personnel man's job analysis."[3]

The differential piece rate. The differential piece-rate system of wage-payment was devised by Frederick W. Taylor, as the method to utilize after conditions had been standardized, jobs studied, and tasks set. The system has two piece rates, a high rate, which is paid to workers who achieve the set task or better, and a low rate, which is paid workers who fail to achieve the task. The high rate is set at a point considerably above the community standard, while the low rate is set at a point below the standard of the community. Thus the task time for a given job might be two hours, with high rate \$2.00 for the task and the low rate \$1.20. If the worker did the job in two hours, he would receive \$2.00 or at the rate of \$8.00 per eight-hour day. If the worker took two and a quarter hours he would receive \$1.20, or at the rate of \$4.27 per eight-hour day. Although this last figure is somewhat misleading, since it may be assumed that no worker allowed to work under this system would fall down on every job during the day, nevertheless, it will be seen that the system is severe on the worker who fails to make the task.

The formula for computing the daily earnings under Taylor's system is as follows:

Below task, $E = NR_1$

R_1 stands for the lower piece rate which is intended to be a penalty for not reaching a task.

At or above task, $E = NR$

[3] See Charles W Lytle, *Wage Incentive Methods*, The Ronald Press Company, New York, 1938, p. 422

R in this instance is the standard rate that the worker is supposed to earn. The assumption was that the management had gone to great trouble and expense to insure that all management factors were properly working, and the only reasons for failure to do the task within the allotted time would be within the control of the worker. If the worker were a first-class man, he would make his task If he were not a first-class man, and could not be trained to be a first-class man, he would not be wanted, and, in fact, if he continuously failed to make his task he would be discharged. First-class men, making their task, would receive a compensation which would distribute between them and the management the savings of greater production.

The Taylor differential piece rate is not found, in its original form, in extensive use in industry today. The culling action at the point of achieving the task was found to be so extremely severe that the measurement of the task and the control of conditions set for the workmen had to be guarded with extraordinary care, in order to avoid complaint or feeling of injustice on the part of the workmen. The fact that the Taylor differential piece rate does not guarantee a basic day wage is, therefore, the primary reason why it has fallen into disuse. Mr. Taylor recognized this point himself, for he said, "When, however, the work is of such variety that each day presents an entirely new task, the pressure of the differential rate is sometimes too severe. The chances of failure to quite reach the task are greater in this class of work than in routine work, and in many such cases it is better, owing to the increased difficulties, that the workman should feel sure at least of his regular day's rate."[4]

The task-and-bonus system. The system known as the task-and-bonus system was devised by Mr. H. L. Gantt while associated with Mr. Taylor in his work at the Bethlehem Steel Company. In the later years of Mr. Taylor's life, he became a very hearty advocate of the use of the task-and-bonus system in practically all classes of work.

The idea back of task-and-bonus work is that an equitable bargain must be struck between the company and each employee. If the task is accomplished, the company will receive a definitely known minimum output at a lower total cost per piece than under the older wage-payment systems. In return for his effort to make the task which the company has set, not only does the workman receive a reward which is large enough to make him wish to accomplish this amount of work, but also he *is guaranteed his hourly rate if he fails to reach the task.* If he accomplishes the task, he is paid at his regular hourly rate for the time allowed for the task, plus a percentage of that time. This is equivalent to a high piece

[4] Frederick W. Taylor, *Shop Management*, Harper and Bros., New York, 1919, pp. 78-79.

rate. Thus the workman has all the advantages of day work on a task he does not meet and all the advantages of high piece rates if he is proficient. The basing of the high rate on a day wage, although it takes the form of a piece rate, allows different rates to be given different workmen, where this is desirable because of the varying lengths of their service, or differing all-round abilities. The task-and-bonus system is built on the idea of the worker's earning the bonus every time. This point is of some importance when considering the relative merits of this system and differential piece rates. Both Taylor and Gantt paid a bonus to the foremen. Gantt gave an additional bonus to the foreman when all his men attained their tasks. This system is not one to use in a transition period.

The bonus, under the task-and-bonus system, will be determined by the individual concern in accordance with its particular needs. It will ordinarily range from 20 to 50 per cent of the task rate. Gantt actually varied this bonus percentage all the way from 20% to 100%, depending entirely upon the nature of the work. On the assumption that the bonus is 33⅓%, which is fairly typical for ordinary machine shop work, the formulas for computing the daily earnings for the Gantt plan are as follows:

$$\text{Earnings up to but not including task,} \quad E = TR.$$

$$\text{Earnings at or above task,} \; E = SR + \frac{SR}{3} = 1\tfrac{1}{3}SR.$$

To generalize this formula to include any per cent that may be used as a bonus, let p represent the required per cent. The formula will then read: $E = SR + pSR$.

To illustrate the workings of the Gantt system, let us assume that A, B, and C respectively produce 28, 32, and 36 pieces in a day of eight hours; that the bonus is 33⅓%, the task calls for 32 pieces per eight-hour day, and the rate is 50¢ per hour. The respective earnings would be as follows:

1. $E = SR + \tfrac{1}{3}SR = 1\tfrac{1}{3}SR$.
2. A would earn 8 × 50¢ = \$4.00, since he gets the guaranteed day rate.
3. B would earn 8 × 50¢ + ⅓(8 × 50¢) = \$5.33 or 1⅓(8 × 50¢) = \$5 33.
4. C would earn 9 × 50¢ + ⅓(9 × 50¢) = \$6.00 or 1⅓(9 × 50¢) = \$6.00.

The system is in substance a day wage for substandard workers and a task rate for men who are standard or better. In reality this task rate is equivalent to a high piece rate expressed in terms of standard hours rather than in terms of individual pieces. It is possible to compare the efficiencies of different departments by comparing the standard hours worked in each in relation to their actual hours worked. The Gantt

system avoids criticisms that are made of the sharing principle common to the Halsey and similar plans. It is easy for the worker to compute his wage. The Gantt plan, when installed under the guidance of Mr. Gantt, made wide use of charts to show the worker daily just where he stood in relation to attaining task. This chart showed not only the status of the individual worker but also the corresponding status of his fellow workers, thus creating friendly rivalry.[5]

Relation of task systems of wage payment to scheduling and cost systems. Two major advantages of any task system of wage payment, and particularly task-and-bonus, are its beneficial effects on cost predetermination, and hence quotations of selling price, and on scheduling work through the shop, and hence production control. It is in these respects that it differs most sharply from straight piece rates based on job study. In fact, were it not for these points, there would be no real difference between task-and-bonus and the straight piece rate with guaranteed day rate. Under the latter system the guaranteed day rate is usually somewhat lower than the amount which can be earned on piece rate if the time set by job study be reached. There are thus several intermediate stages between the number of pieces equivalent to the day rate and the number equivalent to the standard. Under task-and-bonus there is no such condition. The day rate holds until the task is achieved, when there is a sharp jump in the wage, caused by the payment of the bonus. This sharp jump at the task point has the effect of causing the worker to reach the task practically every time. Thus it is possible to predetermine overhead costs, and use these predetermined overhead costs in developing standard costs. Furthermore the pull toward task time makes it possible to schedule and despatch operations in the shop with the assurance that machines will be available at stated times. Although five or ten minutes on one operation makes no difference in this matter, accumulations of such times over many jobs may readily disorganize a whole shop schedule.

The Curtis Publishing Company, of Philadelphia, made a very successful adaptation of task-and-bonus to their factory operations and to allied work. The accompanying illustration (Fig. 133) shows one of their work tickets for their trucking division. The various runs which their trucks made to warehouses, freight stations, post-offices, etc., were carefully studied and timed. Each run was evaluated at a certain number of points, on the basis of 100 points for a fair day's work. As a driver finished a run, his work ticket was punched, thus giving him current information as to whether he was ahead of or behind his task. For each of the first 5 points above 100 he received 10 cents additional,

[5] See Charles W. Lytle, *Wage Incentive Methods*, The Ronald Press Company, New York, 1938, pp 209-216, for a detailed discussion of the Gantt Plan.

and for each succeeding point 2 cents. The urge to reach the task and go slightly beyond is evident. This was made possible of accomplishment because the basis of 100 points was in reality, based on the job

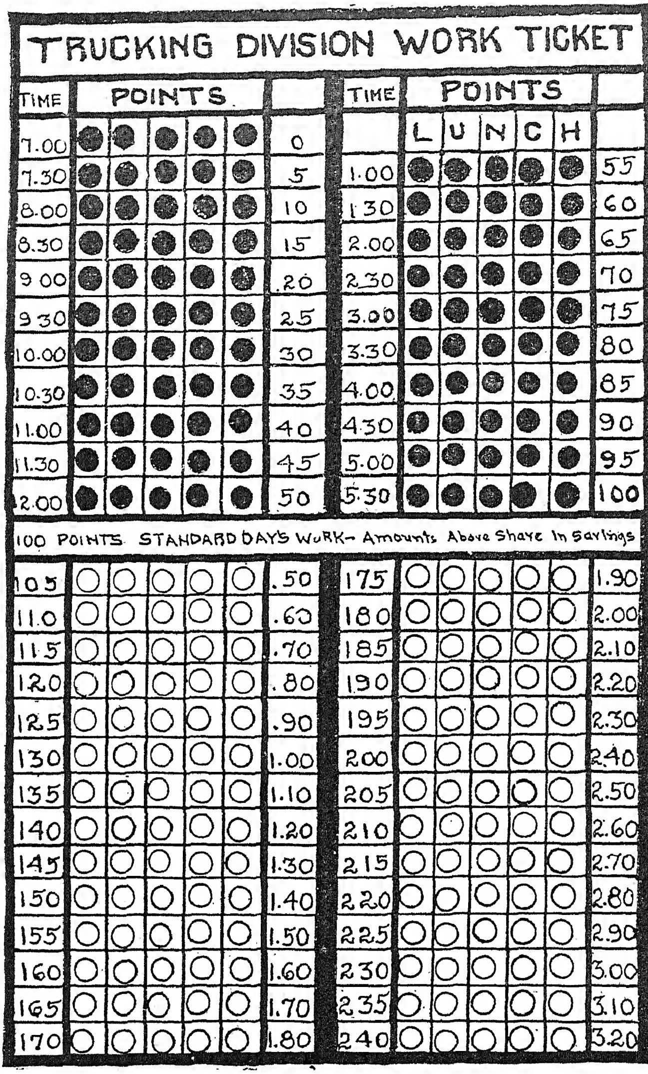


Fig. 133.

studies, somewhat low, and a trucker could easily reach 102 or 103 points in making his standard task. Routes through uncrowded streets were carefully mapped for him, and it was only under the most unusual conditions of bad weather that he was prevented from making 100 points or

more through causes outside his control. All trucks were carefully governed as to speed to prevent violation of speed laws, and the savings came from attention to the job and rapid loading and unloading.

The Emerson efficiency wage. The system of graded bonuses first developed by Harrington Emerson is somewhat similar to the task-and-bonus system. The day *wage is guaranteed,* regardless of performance. It differs in that bonuses are given to workers whose efficiency is less than 100 per cent, these being graded from the starting point up to 100 per cent, and in that efficiencies are not determined on a particular job, but over a pay period or longer. There is thus less of the drive on the worker to make task time on each particular job, because if he falls a little behind on one job he can make up on the next. There is, furthermore, a gradual pull on the worker, and a worker who is 98 per cent efficient makes more nearly the wage of the 100 per cent man than under the task-and-bonus system. Workers who are over 100 per cent efficient under the Emerson plan do not receive quite the wage of workers under the task-and-bonus system, for they receive their basic wage for the allowed time, but their bonus (which is usually 20 per cent) is figured on the time actually worked rather than the allowed time.

The efficiencies are expressed in terms of a percentage. Thus, if in one period a worker has actually worked 96 hours and has done work for which the standard time is 84 hours, his efficiency is 87½ per cent. If he has done work for which the standard time is 91 2 hours, his efficiency is 95 per cent. If he has done work for which the standard time is 105.6 hours, his efficiency is 110 per cent. A sample bonus table under the Emerson system is as follows:

TABLE 11

EMERSON BONUS PERCENTAGES

Percentage of Efficiency	Percentage of Bonus	Percentage of Efficiency	Percentage of Bonus
67 00 to 71 09	0 25	89 40 to 90 49	10
71 10 to 73 09	0 5	90 50 to 91 49	11
73 10 to 75 69	1	91 50 to 92 49	12
75 70 to 78 29	2	92 50 to 93 49	13
78 30 to 80 39	3	93 50 to 94 49	14
80 40 to 82 29	4	94.50 to 95 49	15
82 30 to 83 89	5	95 50 to 96 49	16
83 90 to 85 39	6	96 50 to 97 49	17
85 40 to 86 79	7	97 50 to 98 49	18
86 80 to 88 09	8	98 50 to 99 49	19
88 10 to 89.39	9	99 50 to 100 00	20.

The formula for computing the earnings according to the Emerson Plan are as follows:

Earnings from 66⅔% of task up to task, $E = TR + p(TR)$. The value of p is to be found in the table above.

Earnings at and above task, $E = TR + (S - T)R + .20TR$ or $E = SR + .20TR$.

On the basis of Emerson's bonuses, the wages earned by the worker whose base rate was 50 cents per hour under the percentages of efficiency indicated would be:

Per Cent of Efficiency	Base Rate	Bonus	Total Wage, Two Weeks
87½	$48 00	$3 84	$51 84
95	48 00	7 20	55 20
110	52 80	9 60	62 40

Under the Emerson and similar systems of graded bonuses, there is less pulling power on the worker to make task time, with all its attendant management advantages. Since efficiencies are determined over a pay period, a worker cannot work at maximum pressure on one job, thereby making a very high rate, and then take things easy on the next job, with assurance of a good day's wage. However, under task-and-bonus, disciplinary action will promptly eliminate any such program on the part of a worker.

Under the Emerson Plan earnings of the workers are posted daily. This daily posting of earnings mitigates somewhat the criticism that the plan is difficult for the worker to understand. The system creates much clerical detail and from this standpoint is expensive. In spite of its difficulties some progressive industries are using the system at present.

The Bedaux-point system. This system is representative, and was perhaps the first of a number of point systems which provide a common denominator, man-minutes, to which human activity in all industries may be reduced. Percentages of fatigue, predetermined by class of job, are added to selected operation time to give task time. Task time is then represented by a number of "B's" equal to the number of man-minutes in the task time.

Base rates for each operation are set, expressed in terms of cents per hour. This affords basic comparison between operations. Wage earned is equal to the money value of the total number of "B's" produced. Day work and lost time that is not the fault of the worker are paid for at the rate of 60 "B's" per hour. The operator receives the base rate for each operation plus a fraction of that base rate expressed as "premium

B's," or payment for the additional "B's" which he has done in that hour. If standard base rates are not reached, the operator nevertheless receives such rate for his performance. This amounts to a guaranteed day rate.

The chief contribution of such systems is that all work is broken down to common denominators, and hence comparison between departments or plants is simplified. The Bedaux Plan makes careful use of job standardization and time study. The Bedaux engineers do not claim to have a standardized program for all situations but lay great emphasis upon adjusting their program to suit individual needs.

The formulas for computing the earnings of the worker under the Bedaux Plan are as follows:

Earnings at or below task $= TR$.

Earnings above task $= TR + p(S - T)R$.

p represents the per cent agreed upon as the share of the time saved to go to the worker.

S is found by dividing the number of B's by 60.

In several of the recent installations the full time saved has gone to the worker. When this is the case, $E = SR$.

The ability to compare the efficiencies of departments regardless of the nature of the work is a strong feature of this program. To illustrate, if the total point hours worked in a given department be 4,800 and the actual number of hours worked be 60, then the point hour for the particular department would be $\frac{4800}{60} = 80$. This can easily be used as an index of efficiency of the department.

Beginning operators may be paid a rate below the standard base rate, and not advanced to the standard rate until, by maintaining a production of 60 "B's" per hour for several successive days, they have indicated that they are capable of earning the base rate that has been set.

One hundred per cent time-premium plan. The One Hundred Per Cent Time-Premium Plan is a modification of the straight piecework wage program with the unit of payment time instead of the piece. It is also a modification of day rate based on production described on page 427. The result is identical with the Bedaux Plan when the worker is given the full time saved, on the assumption, of course, that the standard task is the same for both systems. A task time is set for each operation. Each class of work may have a specific rate per hour or the worker may be given a definite rate per hour regardless of the work he performs. In case the hourly rate is given to the class of work rather than the worker, the worker's time and efficiency relative to the standard task must be accumulated for each job in order to compute his earnings for the day. The worker is usually guaranteed the base rate for each job. To illustrate, assume that the worker works four hours on job A whose

	Wage Systems Not Based on Job Study				Wage Systems Based on Job Study						
	Day Rate	Piece Rates without Job Study	Halsey	Rowan	Day Rates Based on Production	Piece Rate	Differential Piece Rate	Task-and-Bonus	Emerson	Bedaux	Wennerlund
Guaranteed Day Rate	Yes	No	Yes	Yes	Yes	Possibly	No	Yes	Yes	Yes	Yes
Incentive for Worker to Reach Maximum Productivity	No	Not Usually	Possibly	Possibly	Possibly	Yes	Yes	Yes	Yes	Yes	Yes
Maximum Spur to Best Possible Management	No	No	No	No	No	Possibly	Yes	Yes	No	Yes	No
Spur to Worker to Reach Carefully Set Task	No	No	No	No	Possibly	Possibly	Yes	Yes	Somewhat	Yes	Somewhat
Payroll Computation	Easy	Fairly Easy	Difficult	Very Difficult	Easy	Fairly Easy	Fairly Easy	Fairly Easy	Very Difficult	Fairly Easy	Very Difficult
Labor Cost Predetermination	Impossible	Easy	Difficult	Very Difficult	Fairly Easy	Easy	Fairly Easy	Easy	Difficult	Easy	Difficult
Overhead Cost Predetermination	Impossible	Difficult	Difficult	Difficult	Difficult	Difficult	Fairly Easy	Fairly Easy	Difficult	Difficult	Difficult
Quality Maintenance	Entirely dependent on character of product, methods of supervision and inspection, and other means taken to promote quality.										

Fig 134.

rate is 70¢ per hour and produces 5 standard hours work, and finishes the eight-hour day on a job whose rate is 72¢ per hour producing 4 standard hours. His earnings would be: $5 \times 70¢ + 4 \times 72¢ = \$6.38$. In case the rate applies to the worker instead of the job his earnings in the case given above would be as follows on the assumption that his hourly rate is 70¢ per hour: SR or $9 \times 70¢ = \$6.30$. The plan is simpler where the rate applies to the worker instead of a job. This plan has the advantage over straight piecework in the event of raising or lowering the base rates. The standard times remain the same and the only change required is the hourly rate This simplifies the accounting problem in case of changes and possibly has certain psychological advantages.

It is possible under the plan to give recognition to length of service of a worker by raising his hourly rate. When this is done, the One Hundred Per Cent Time-Premium Plan embraces many of the characteristics of the Measured Day Work Plan.

The accompanying chart (Fig. 134) is a ready reference for comparison of the various wage-payment systems, and for information concerning their effect on various phases of operations.

CHAPTER XXXV

SPECIAL FORMS OF WAGE PAYMENT

Group bonuses. When the nature of the task requires that workers be formed into groups, the members of which are dependent on one another as regards output, some form of group bonus usually proves most practicable. This plan also has been used successfully by putting the entire personnel of a department on group bonus, although their work is not directly related. Many of the incentive types of wage payment can be used in group bonus, or group incentive, development.

The paramount advantage of group bonus is that it promotes teamwork in that group to which the bonus is applied. Since but one premium or bonus need be figured for each group involved, the amount of clerical labor is reduced somewhat. It also may be used to reward foremen and other supervisors by including them in the group or departmental unit that is subject to the bonus. It is simple for the management to check the efficiency of groups, departments, and the plant as a whole from day to day. No complicated statistics are necessary, but merely a review of a few time tickets. Indirect workers, even sweepers and janitors, may be brought to have cost reduction within their department as their primary goal. The co-operation of all workers is enlisted in bringing up substandard workers.

The "neck-of-the-bottle" operation receives the most attention from the group itself. It is a fact that wherever there is a constant "hold-up" operation, in lone production, the "group bonus" plan will always speed this point up to the capacity of the balance of the line. The slow operations are assigned to the fastest men in the group, and thus all the help necessary is given to get the maximum production. There are "tricks of the trade" to every operation, and with several workmen on the "firing line" the best and fastest methods are worked out in very short time, by the group members.

The apparent advantages of group bonuses have led to their use under conditions to which they are unsuited. If the jobs are entirely unrelated, it may be that the spurring action of one employee on another will not be as effective as anticipated, and under such conditions poor operators will profit from the better-than-normal work of the best workers. Furthermore, under some conditions the best workers will feel that

an unfair advantage has been taken of them by figuring their wages partly on the efforts of inferior workmen. Therefore, although group bonuses will usually work to advantage when a given operation is performed by several workers whose individual efforts are inseparable for wage-payment purposes, they will not always succeed when applied to whole departments. In such cases, individual day rates will have to be set in any case, and the bonus for each worker will be a similar percentage of his day rate, but a different amount. It is probable that the relative ease of setting bonuses by groups will not compensate for the inaccuracies which occur. Bonuses under such conditions might be paid on an individual basis.

Group bonus, because it makes one worker desire to help another, results in developing all-round men. This is of importance at times when production must be decreased, for, by reducing the number of men in the group, production is cut automatically.

Disadvantages of group bonus plans. Among the disadvantages of group bonus is the possible severity of the arrangement. The fact that some workers receive wages which are based partly on the output of others engenders ill-feeling and back-biting under some conditions. Rate-cutting is just as easy with group bonus as with any other type of wage payment. If the management feels that the men are making too much money, non-productive workers, such as a sweeper, can be added to the group, with the explanation that "the management had not included him through oversight and that he really was a part of the group at all times." It is apparent that most of these disadvantages are not inherent in the system of group bonus payments as such, but arise largely from the failure of management to perform its function properly. It is true that the payment of a group may offer management an excuse for its action, however, such performance seldom deceives anyone other than management itself.

The size of the group. The size of the group is particularly important if the group bonus plan is to exert a strong incentive to high production or quality performance. Groups have in actual practice varied all of the way from 4 or 5 to as many as 1,000 or in a few cases even more. When the group is small enough so that each man can see the results of his individual efforts, the system functions more effectively. It is difficult to set a definite mathematical limit to the exact size of a group to be desired. Probably a group ranging between 10 and 20 workers can possess all of the desirable qualities sought. The worker can see the results of his efforts more clearly in a group of 10 than in one of 20. The elimination of one worker from a group of 21 leaves a saving of 5% to each of the remaining workers on the assumption that they absorb the additional work. The elimination of one worker from a group of

11 results in a saving of 10% to the remaining workers under the same conditions. When the worker sees his bonus increase 10% this means a great deal to him.

A second factor in the desirable size of a group is the influence of the unofficial leader of the group. Practically all groups of moderate size have a recognized leader and pace setter among the workers. This man may be the sub-foreman or, most frequently, one of the workers. When the group is small enough for this leader to make his influence felt best results are derived from the group bonus. The group through its unofficial leader will exert pressure upon lazy members of the group who are holding down the group earnings The influence of the worker leader diminishes very rapidly when the group exceeds 20 men. It is even more effective with a group smaller than 20.

Rate for beginners. As in most other wage plans the rate to be paid the beginner is not easily solved from the standpoint of managerial cost predetermination and justice to the learner. The value in terms of actual productivity of the beginner is frequently very low for the first few days. It naturally becomes relatively higher as experience is acquired. Even though the beginner may be given a relatively low day rate at first, he will often take from the group more than he contributes. This will not be conducive to his acceptance by the group. Practice varies in handling this situation. In some cases the learner does not share in the bonus for a short period, after which he is placed in the regular group. In other cases he does not share in the bonus until he has reached or nearly reached standard performance. In other situations he is placed in the group from the beginning. When the group is large the addition of the learner does not pull down the earnings of the other members so much, but it becomes a real problem in the smaller groups. The solution usually results in a compromise.

Foremen's bonuses. In group bonuses, the salaries of the foreman and his assistants are added to a departmental payroll, and foremen receive their bonuses as a part of the group division. Therefore, the production bonus that a foreman receives is directly proportional to the productivity of his department. This is an essential feature of any foreman's bonus scheme. In the Bedaux system it is easy to determine the number of "B's" produced by a department, and to give the foreman a bonus based on a previously determined scale Under the task-and-bonus scheme a foreman may receive a bonus based on the number of workers under him who are themselves receiving bonuses.

One still meets frequently in industry the foreman who hesitates to teach the workers under him for fear that one of them may learn as much as he knows and thus secure his job. The payment of production bonuses to foremen is, in a sense, additional payment for teaching the

workers all that he can. The foreman also becomes directly concerned with the removal of all obstacles toward increased production, instead of leaving this to the higher executives or to the methods men. Foremen's bonuses can be worked out for any phase of the operation of their departments, as, for instance, quality, or accident reduction.

Foreman's bonus based on over-all performance. Bonus plans for foremen have been used in many forms to accomplish specific purposes. The foreman's task is not one simple one but is made up of many factors, none of which can be neglected if his function is to be discharged. Several wide-awake enterprises have made the over-all bonus for foremen an integral part of their incentive program for these key men. Others have devised such a program for all executives from the grade of foremen up Simplicity should be considered in all bonus plans. The plan, to be effective, must be such that the individual can see the results of his efforts, not merely the pay check at the end of the period.

The bonus payment plan in use by the General Household Utilities Company of Chicago is illustrative of such a program. Their bonus is based upon the following factors within the control of the foreman: [1]

1. Departmental efficiency as reflected in costs, worker's earnings, etc.—50 per cent.
2. Budgetary control based on the operating expense budget—15 per cent.
3. Quality control—relation of rejected material and scrap to the amount of accepted materials produced—15 per cent.
4. Control of excesses:
   a. Day work for incentive-plan groups above the regular allowance—5 per cent.
   b. Overtime arising from poor planning and mismanagement on the part of the foreman—5 per cent.
   c. Productive materials used in excess of specified requirements —5 per cent.
5. Base rate control—operating within or under standard base rates established for the various tasks of the department—5 per cent.

The computation given on the following page illustrates the functioning of this program for a supervisor in a piecework department. It will be noted that good performance is rewarded while sub-standard performance is penalized.

[1] See *Factory Management and Maintenance,* Vol. 96, No 6, June, 1938, for a complete discussion of this plan. The material used above is adapted and quoted by permission of the publishers, McGraw-Hill Book Company, Inc., New York, and the author, Mr. J. E Osterman, Industrial Engineer.

TABLE 12

SUPERVISORY BONUS ANALYSIS

Department "A" John Doe, Supervisor April, 1938

Elements	Grade	Extension	Penalties	Bonus
a. Department Efficiency	50			
b. Budgetary Control	15			
c. Quality Control	15			
d. Excess Daywork	05			
e. Excess Overtime	05			
f. Excess Materials	05			
g. Base Rate Control	05			
h. Supervisor's Salary		$ 200 00		
i. Department Efficiency		125.00%		
Bonus—$(i - 100\%)ha = 0.25 \times \$200 \times 0.50$				$25 00
j. Budget Allowance		$ 600 00		
k. Budget Expended		$ 500.00		
Bonus $= (j - k) = \$100 \times 0.15$				$15 00
l. Scrap Allowance		$ 500 00		
m. Actual Scrap				
Bonus $= (l - m)c = -\$50 \times 0.15$			$7 50	
n. Allowed Daywork		$ 50 00		
o. Actual Daywork		$ 25.00		
Bonus $= (n - o)d = \$25 \times 0.05$				$ 1 25
p. Allowed Overtime		$ 50.00		
q. Actual Overtime		$ 75.00		
Bonus $= (p - q)e = -\$25 \times 0.05$			$1 25	
r. Excess Materials Allowed		none		
s. Actual Excess Materials		$ 10.00		
Bonus $= (r - s)f = -\$10 \times 0.05$			50	
t. Labor at Standard Base Rates		$2,500 00		
u. Actual Labor		$2,450.00		
Bonus $= (t - u)g = \$50 \times 0.05$				$ 2 50
Total			$9 25	$43.75
Net Bonus Paid				$34 50
Note: All negative results become penalties				

Quality bonuses. In considering incentive wage systems the question is constantly asked, "Do not such systems tend to increase quantity of production at the expense of quality?" At times, in actual usage, there seems to be so much stress on securing maximum quantity of production that quality cannot help but suffer. This has caused manufacturers producing a quality product to hesitate to use such systems, particularly

to turn to them from the day rate. There are two general remedies which can be applied to this situation that will help keep up quality equally with quantity while the worker is trying to earn his premium or bonus wage. The first of these remedies is to insure stringency of inspection; the second is to utilize some sort of quality wage bonus.

If strict inspection standards are maintained and the workers know that quality must also be a result of their efforts or material will be returned to them for reworking or they will be otherwise penalized, quality will usually be maintained. In the usual type of work a proper inspection system will ordinarily prove to be sufficient inducement to secure quality. Bonuses for quality are more frequently found only where quality, not quantity, is of paramount importance, though they are also used at times where quantity is desired.

Action by the inspection force of a plant has the negative effect of penalizing the workers Quality-bonus systems operate in the opposite way. They are positive inducements toward better quality and pay the worker for quality instead of merely penalizing him for lack of quality. Quality bonuses may be used with any wage system that has been discussed. In some cases they may form the only type of incentive wage that is used. It will thus be observed that quality bonuses divide themselves into two classes: (1) those which are utilized where quantity bonuses are impossible, or at least impractical, and (2) that quality bonus which is used in conjunction with some form of quantity bonus to make a composite wage system in which the pull on the worker will be toward both quantity and quality.

It is easy to combine the payment of quality bonuses with bonuses for quantity. The combining of such bonuses will prove an immediate check on rapid increase of production without regard to quality. Thus, in the weaving of cloth, a bonus may be paid on the production which is secured from the loom, while another bonus may be paid if the defects which are discovered in a certain number of yards of cloth are kept below a certain number. The relative amount of bonus to be paid for quantity and quality will vary with the importance of quality in the particular instance, as for example, the value per yard of the finished fabric.

A combination inspection system and quality bonus has been devised which is known as the "Debit and Credit Bonus." This is used on processes which involve a number of very short operations, as in some of the needle trades, where the cost of inspection after each operation would be prohibitive. Under this system each operator forms a check on all preceding operators for the quality of their work done. If she discovers a defect in quality she reports it to the foreman and receives a stipulated bonus for so doing, which is charged against the worker

making the error. It is an automatic inspection scheme which is very harsh in its application, but which frequently has proved very effective in bringing up quality on short operations.

Attendance bonuses. The next general type of special bonuses to be considered may be termed "attendance" bonuses. These are special bonuses paid for perfect attendance or a percentage of attendance up to a specified standard. Attendance bonuses may be for attendance only or may include extra payment for promptness, or the payment for promptness may be the only type of attendance bonus granted. Bonuses of this type are frequently paid in money, but are often paid in the form of a vacation or added days on vacation. If paid in money the amount is not usually very large. If paid in vacations, a basis that is frequently used is one day's vacation (or extra vacation if the factory is already on a vacation basis) for each month of perfect attendance.

Attendance bonuses are of great value in increasing output, since they aid continuity of attendance on the part of the working force, thus insuring that any production program that is mapped out will not be hindered by lack of personnel to carry it through. The promptness bonus is particularly advantageous in this respect, inasmuch as it usually results in almost uniformly prompt attendance throughout the factory. This enables the production department to know, soon after the factory doors open, what vacancies in the factory force must be filled in a given department on that day, in order that production may be kept flowing smoothly and up to schedule.

There is one element in attendance bonus payment that is not altogether pleasing to a large number of plant executives. That is, that the payment of such bonuses results in the duplicate payment for something that the factory is already paying for. It is claimed that when a person is engaged he is expected to be at the factory on all working days and to be there promptly. Therefore, an attendance bonus should be unnecessary and is an undesirable payment. This argument has much strength in theory, but the facts of experience have indicated that a small attendance bonus is an expenditure well made, as it most distinctly does serve to bring in the workers on time every working day and also decreases the days "out." In times of slack production attendance bonuses are likely to be quickly eliminated.

Length of service bonuses. One criticism that is to be found in paying all men on a given job the same rate of pay, or pay varying only as their production varies, is that it does not take account of the length of time that the worker has been with the company, his loyalty, general knowledge of plant conditions, and ability to do more than one type of work. Some plants give workers of long service higher base rates than newer workers for similar work. A soap manufacturer has combined variable

hourly rates, based on length of service, with piece rates. A certain number of units, or pieces, is set as an hour's task. Different workers are paid different rates per hour, based on length of service and ability to do more than one job, but their wage is determined by the units set for a given job. An interesting advantage of this method is that the task, being set on units per hour, is expressed in the same terms for every worker, regardless of their individual base rate.

Some plants have paid for long service by bonus, rather than by either of the methods just described. This bonus, usually a percentage of earnings, is paid regardless of the type of work which is performed or the money earned in a given period, and it increases as the length of service increases. Some plants have begun the payment of service bonuses as soon as six months after the employee has entered the employ of the concern, while many have deferred the payment for as long a period as five years. The basis of this payment will depend on the type of worker that the company desires to reach, and also on the length of service that is necessary to make the employee really of extra value from a producing standpoint.

Overtime or odd-shift bonuses. Payment for night and Sunday work, as well as for overtime work, is frequently made on a bonus basis. The familiar "time and a half for overtime" is not the only method of paying for this type of work, although it is more common for overtime work than it is for night or Sunday work. Some of the plans for payment of bonus for night-shift work are as follows: (1) payment of a certain stipulated number of hours' pay per week in addition to the pay for the number of hours actually worked on the night shift, e.g., payment for three or five extra hours, (2) payment of a bonus of a certain number of cents per hour worked on the night shift, as 2 cents or 5 cents per hour, (3) payment of a certain percentage of the day rate in addition to the day rate for night work, as 10 per cent or 15 per cent. The increase of the base rate for night work need in no way affect the operation of an incentive wage system, as the premium or bonus can be figured out on the night base rate as easily as it can be figured out on the day base rate.

Mr. William L. Munger, Research Director of the United Automobile Workers of America, reported the status of the major provisions in 501 collective agreements in the *Labor Information Bulletin,* June, 1938. The provisions on the following page are of interest in connection with the wage program.

While this tabulation can not be interpreted as illustrative of the practice in all industry it does show the prevailing tendency in one very large mass production group. Extra pay for overtime, holidays, and

TABLE 13

PROVISIONS OF 501 U A. W. AGREEMENTS

Provision	Number of Agreements
1. Time and one-half to double time for Sundays and holidays .	439
2. Time and one-half for overtime	436
3. Vacations with pay	93
4. Extra bonus for night shift. . .	76

Sundays seems to be quite general at present.[2] Vacations with pay for workers is increasing but is by no means the prevailing custom. Extra pay for night shift work is even less well established than vacations with pay.

In view of the prevailing tendency to pay additional compensation for overtime it is interesting to note the changed attitude among industrial managers during the past twenty years. Speaking before a group of industrial managers in Milwaukee in June 1921 on the general subject of fatigue, Harrington Emerson said: "Of all the absurdities I know of, the one of paying overtime—50% extra for overtime—is one of the greatest, one of the most foolish. Any worker who considers for a minute will say, 'If you can pay me 50% more wages when I am tired, for work three or four hours after the eight hours work is done, you must be cheating me during the eight hours that you are paying me the flat wages,' and I see no escape whatever, from that conclusion."[3] This statement of Emerson's does raise an interesting question. Time changes and managerial policies must be adjusted to meet changing customs. The questions raised by Emerson would not be considered by a group of industrial engineers today.

Payment of salesmen. There is no one type of payment for salesmen that will fit all cases. Straight salary has been paid less frequently than was formerly the custom, since the same elements that make for inefficiency under the day rate in industry have been seen, under newer

[2] The Fair Labor Standards Act of 1938 requires time and one-half for time worked during any seven-day period in excess of the prescribed maximum. See Richard A Lester, "Overtime Wage Rates" in *The American Economic Review*, Vol. XXIX, No 4, Dec. 1939, pp. 790-792, for an interesting discussion of the theory involved.

[3] The Society of Industrial Engineers, Vol. IV, p 262, No. 5; June, 1921, "Industrial Leadership," *Complete Report of the Proceedings of the Spring National Convention, Held Under the Auspices of the Society of Industrial Engineers*, Milwaukee, Wisconsin, April 27-29, 1921.

sales conditions, to apply to salesmen under straight salary. For the same reason that piece rates, without guaranteed day rates, are ineffective, any commission or bonus plan is usually coupled with a basic salary or drawing account. Commission over straight salary is paid for sales above a minimum quota that has been set, and in the case of drawing accounts, these are paid back by the salesman through commissions earned, after which all commissions earned are his. Many firms give salesmen bonuses for unusually good performances.

Basic salaries can be determined on the basis of the salesman's past worth to the company plus his knowledge of the company's products, and with regard to the type of customer with whom he is dealing. Commissions vary with the extent to which sales price exceeds cost, and with the total of goods sold. Frequently the same salesman will receive different commission rates for selling different products at the same time. A slow-moving product that seemingly is encountering considerable sales resistance may carry a larger commission than another article that is moved more readily. The same product may carry a different commission to travelling salesmen in different territories, the higher rate being paid to the salesman in the territory less densely populated or less productive. The commission for a sales person in department stores is sometimes adjusted according to the seasons in order to maintain a more equitable wage. Where this is the program the commission for the slow period, such as August, would usually be higher than for the month of December.

Straight salary payment leaves a company free to transfer a salesman to any part of its territory, and commission encourages overselling to the neglect of service, especially for salesmen who do not expect to stay with a company for a long time. Nevertheless, most good salesmen desire to be paid directly in accordance with the results which they achieve, and some form of commission is used almost universally.

Executives' salaries. Job study of executives' work is almost solely for the purpose of setting salaries. Little can be done through job study in the development of executive methods. While the detailed character of an executive job has little relation to the proper salary to be paid, yet there is much to be gained in large companies through the development of a salary scale for executives based on some of the fundamental characteristics of the several jobs and of the character of the men needed to fill them.[4]

Among the factors that may be taken into account in setting a scale for executives' salaries are the following: education necessary; amount of business experience necessary; amount of specialized business experi-

[4] See F. Beatrice Brower, *Studies in Personnel Policy*, National Industrial Conference Board, Inc., New York, Feb., 1938.

ence necessary; amount of administrative experience necessary; number of workers supervised; character of workers supervised; and amount of payroll supervised. A table fitting the needs of a particular business can be worked out, with ranges of salary within each step of the table set. Then the salary of an executive whose duties and qualifications come within any step of the table is set on the basis of the salary specified in the table. Changes in payroll affecting executives must usually be studied and approved by one of the major operating officials of the company, and not by rate-setting or similar groups.

PART VII

MANAGERIAL CONTROLS AND OPERATING PROCEDURES

CHAPTER XXXVI

CONTROL THROUGH THE USE OF THE BUDGET

In the modern business world, the extent of control over operations determines in a large measure the profits of the enterprise. Control over the operation of a particular department of a business is difficult to maintain unless it is linked up with corresponding control over departments with which it must mesh in the drive toward business progress. A device for providing this control is the business budget, which has been variously described as: [1]

1. "A method of rationalization whereby—

(Budget) estimates covering different periods of time are by the study of statistical records and analytical research of all kinds, established for all and everything affecting the life of a business concern which it is possible to express in figures.

(Control) These established standards are constantly revised and checked for the periods determined in the light of actual achievement, with the double purpose of correcting the estimates, and of initiating the investigation and correction of causes of discrepancies."

2. "An instrument tending to promote cooperation, coordination, and control.

3. " the word *budget* will be used to mean a particular form in which a sales forecast and plan of management may be expressed that will facilitate their use in management. The term *budgetary control* will be used to mean the way in which such a budget is used to organize, coordinate, and stimulate the activities of executives, and to control income and expense."[2]

[1] National Industrial Conference Board, *Budgetary Control in Manufacturing Industry*, p 11, quoting from an editorial in the Bulletin of the International Management Institute, July, 1930, Geneva.

[2] John H. Williams, *The Flexible Budget*, p. 4, McGraw-Hill Book Co., Inc., New York, 1934.

The administrative budget provides the necessary means of supplying the co-ordination between department plans. The budget idea in business implies the thought of planning ahead, forecasting tomorrow, and laying co-ordinated plans which will lead all major portions of the business along paths that will cross and diverge at predetermined points, so that the business will operate as a unified whole. Business foresight is largely hindsight, and thus administrative budgets must be developed not only by means of forecasts of business conditions as they affect the particular enterprise, but on the basis of past history, carefully interpreted. The form of a business budget, its complexity or simplicity, is determined largely by the purpose sought to be served by the budget, and the nature and type of the organization making use of it. Business budgets are much more difficult of formation than are governmental budgets, since income and expenditures cannot be separated. Unlike budgeting for governmental work, a reduction of expenditures in a business may reduce the revenues directly. Thus, a reduction of an advertising expenditure may reduce the sales, and hence the income, while the reduction of a manufacturing expenditure may directly affect production, and hence the source from which income is derived. This added difficulty, which is an important practical element in the development of administrative budgets, is the most difficult of measurement when visualizing tomorrow during the process of budget development.

Historical Development of Budgeting. Originally the extensive use of budgets in this country was in connection with local governmental bodies, such as cities and villages. Later it spread to counties, states, and eventually in 1921 to complete use by the Federal government. Budgets could be readily adopted by government bodies because the income could be estimated fairly accurately. The application of the budget amounted largely to a parcelling-out of the estimated receipts among the various agencies.

Because of the difficulty of estimating the income of business concerns, not very extensive use was made of budgets until the publication of a book by J. O. McKinsey in 1922. Once the case of application and practicality of budgets was demonstrated, great numbers of industrialists were won over to its use. The greatest progress in budgeting has been made in those trades which have trade associations. These trade associations have fostered the idea and by means of experiment and research have ironed out many of the problems which the administration of a budget presents.

Early budgeting was applied principally to expense, but it was soon expanded to cover sales, production, plant additions and changes, and revenue. The success of the firms which applied it correctly and suc-

cessfully encouraged others to try it, and soon budgeting had undergone an amazing development in business. By 1929 it had become established as an efficient business device whose worth was firmly demonstrated during the depression of the early thirties.

Aims of the business budget. Budgets are necessary for business control, since they provide for a careful item-by-item consideration of departmental programs. They become a check on unjustified optimism or pessimism of departmental heads, and they not only give a target, but a bull's-eye at which those responsible may shoot, and toward which those in charge of the major business activities may direct their control. Not only does the budget make possible the development of departmental programs, but it is a means of curtailing over-expenditures in departments. To check leaks, it is necessary that they be recognized when they are seen. Preconsideration of items of expenditure makes possible the recognition of leaks, both at the time the budget is being considered and during the period of operations that it covers. The budget is also a means of eliminating the misdirection of assets through improper enlargement of facilities at the wrong time. If expenditures for plant enlargement are subjected to a careful survey of their purposes and their justification, with a realization of what they will mean in terms of expansion of sales and production, it is very likely that hasty enlargement plans will be eliminated, and assets retained to operate the plant in phases where they are already needed. Finally, the budget is an unparalleled aid in the development of a financial program. Bankers are steadily and increasingly demanding more knowledge of operations and programs than formerly. They are asking for information, not alone along lines of balance sheets, character, and capacity, but along lines of prospective operations. They are desirous of knowing when loans which they may make are going to be repaid, and in this connection they want the detail of commitments, of prospective earnings, and financial conditions in a way that a budget alone can give. In increasing numbers, bankers are demanding submission of a budget which will definitely indicate when loans are going to be repaid, with substantiating figures, at the time when application for loans is made.

Preliminary considerations in budgeting. Successful control through the technique of budgeting is a matter of long, painstaking growth. Success is not attained at once. Ultimate success may be delayed or even endangered if certain fundamental considerations are not carefully provided for before launching the first budget. The National Industrial Conference Board survey listed some eighteen mistakes or misunderstandings that the companies had encountered with their budgetary programs.[3] The first eight of these mistakes point rather specifically

[3] *Op. cit.*, p. 16.

to conditions that might well have been considered before the original installation, namely:

"1. Expected too much.
2. Installed too rapidly.
3. Inadequate supervision and administration.
4. Bad organization
5. Inadequate accounting system.
6. Inadequate cost system.
7. Inadequate statistics of past operations.
8. Expected results too soon."

Advocates of budgetary control are often guilty of claiming too much for the tool, and the logical result is disappointment on the part of management. Since management really may be "expecting too much," it is not surprising that the budgets are frequently "installed too rapidly." The installation of a budget even under favorable conditions is an educational process. It requires time. The by-products of budgetary installation are frequently more important than the budget itself. Inadequate supervision and administration usually follow a failure of management to recognize the underlying significance of the budget. The budget is a technique of the newer science of management. It requires the same consideration and care that is given to personal supervision in production. Budgeting cannot be reduced to a formula to be solved by a low price clerk. It requires judgment of the highest order. It is better by far not to undertake the budgeting of an enterprise than to doom it to failure from the beginning by "bad organization" and "inadequate supervision." The budget presumes the existence of factual data of past experience from which to construct the budget. One of the prime functions of the budget is to fix responsibility. Unless the accounting system is so organized as to make possible the collection of information with which to fix specific responsibility, the budget should not be undertaken. The budget is not necessarily under the accounting department, but the two functions must work together. The accounting division provides most of the raw material from which the budget is originally constructed and with which it is checked as the period progresses. In case the accounting system is not designed to provide these data, its change to make possible the current collection of the required information must precede any effort at budgetary control. What has been said above regarding accounting is equally applicable to other statistical data that may not come directly under the accounting department.

It is highly essential that the performance of each budgetary unit be measured in terms of those items for which it can be legitimately held

responsible. A preliminary consideration is the determination of those executive levels and individuals that are to be charged with performance. The organization is then constructed to fix responsibility, and to measure performance in terms of this responsibility.

Items to be considered prior to the construction of the current budget. Not only must adequate provision be made before installing a budgetary program but special care should be taken, prior to the construction of each new budget, to include all items that will influence the budget. These factors may be thought of as policy determining or as having grown out of action influencing policies. Some of these major considerations are as follows:

1. Policy with reference to product change, development, or the introduction of new lines. Any major changes will frequently make heavy demands on expenditures for equipment, advertising, and sales effort.
2. Contraction or expansion of production. During every period some organizations are contracting while others are expanding. This is applicable to periods of both depression and prosperity. A contracting program requires special care to avoid catastrophe. An expanding program also requires care to take full advantage of the opportunities offered. A formal declaration of these items will tend to focus the entire organization's attention on the problems involved and thus usually prevent the overlooking of some important item.
3. Modernization of production equipment should be considered. This is very important where such modernization will directly affect departmental budgets.
4. As far as practical, due consideration should be given to salary and wage changes that may be anticipated during the proposed budgetary period.
5. The attitude of the management should be fairly clear with respect to the influence of the position in the business cycle. It is not possible to know exactly the movement that will take place; however, intelligent budgeting cannot be undertaken without careful consideration of the cyclical trend.

With definite policies formulated in terms of the foregoing items the actual budget may be constructed. The extent and detail of budgeting will depend largely upon the magnitude of the enterprise and the relative experience with budgets. By far the most common is the sales budget. In fact the sales budget in many industries is the foundation upon which all budgeting depends. There are times and situations under which the sales budget is limited by the productive capacity or the financial budget;

during recent years, however, the experience has tended to emphasize the budgeting of sales first and then the construction of all other budgets in terms of anticipated sales

The procedure for budget making. The procedure for budget development usually starts with a preliminary conference of the major department heads, in which the trends of the business and of industry in general are considered, and broad lines of progress are mapped out with the aid of the general manager and others who have control of the broad policies of the business. If the controlling factor is the amount of goods that can be sold at a profit under competitive conditions, the first budget that must be constructed before the others can be built is the sales budget. This having been done possibly with the final approval given at the general conference, the departmental heads go back to their separate fields, and prepare budget estimates based on the general program that has been outlined. These budget estimates are usually submitted to one officer of the company who has been chosen for the purpose. This man will ordinarily be the comptroller or the assistant to the general manager. Although the details of the budget may be handled by a lesser official, in reality the general manager is the budget director and the responsibility is his even though details may be handled by his representatives. In a small business the co-ordinating budget officer will in fact be the general manager. He suggests changes to the department heads, founded on his knowledge of basic factors, and with an idea of co-ordinating the activities of the various departments. With this in view, he may call conferences of two or more of the departmental heads, whose estimates must depend on each other and who may seem to be furthest from agreement in their first estimates. When such matters have been adjusted to the fullest degree by this means, the general budget meeting is called; at this time each department head submits his budget, and must meet the criticism and comment of the others present. Although final control of the budget estimates must necessarily be left in the hands of the president or general manager, this budget meeting will ordinarily largely determine the final status of the budget requirements and estimates of the various portions of the business. When finally determined, the budget should be prepared in a satisfactory form and distributed to all interested persons, in order that they may know definitely what is expected of them.

The budget officer, as he develops his major plan, must determine first the desired profit in the light of existing conditions, after which he will consider means of earning that profit. The gross profit should be sufficient under normal conditions to meet all depreciation allocations, any needs for expansion programs and increased working capital, and in addition, the fixed charges and dividends. After the anticipated gross

profit has been decided upon, the amount of sales volume to produce this profit must be determined. This involves full consideration of selling prices, production costs, and individual profits on each item of production.

Methods of making up departmental estimates—sales department estimates. In general there are three methods of constructing a sales budget when proceeding on the assumption that the production departments can turn out all the product that the sales department can sell, namely:

1. Each salesman throughout the country estimates the total sales by items that he thinks he reasonably can expect to sell during the next budget period. These are summarized by territories and a sum total is drawn off for entire anticipated sales. Each salesman's estimate may be increased or decreased by his regional supervisor if the supervisor feels that the particular salesman is either too pessimistic or too optimistic. This estimate is a pragmatic estimate and has the advantage of being in effect a pledge on the part of the men actually in the field to perform.
2. The central statistical division, after having studied past performance of sales by items in relation to certain indices, may build up a scheme of forecasting sales either in terms of total volume or, better still, by products. By using regional information about the general economic situation, this total estimate may be broken down into regional estimates. Certain industries have been experimenting with this method with considerable success. The outstanding problem is to find the proper index, especially one that anticipates performance.
3. A third method is to combine both of the methods above. The statistical estimate is tempered by being checked by the men in the field. At present this seems to be the most promising method. The sales-department's estimate will include a full statement not only of necessary expenditures, but of probable sales and shipments during the budget period, subdivided by kinds and unit value as well as by total value. The estimate of shipments is equally important with that of sales, as upon this will largely depend the time when cash receipts may be expected. This estimate must be based on a consideration of past history, as well as a full consideration of the seasonal factors that may be involved, business and competitive conditions in the industry, the obsolescence or style factors which may be present, traffic conditions, and the relation to the manufacturing program, both as regards production needs and the extent of unfilled orders. An important consideration is the available demand at various selling prices, with the margin of profit that is

left under each condition. The cost of securing large volume, with full data from the manufacturing departments, will in a large measure determine the output that the sales force will attempt to sell.

Manufacturing department budgets. If standard articles are being manufactured, the number in each unit of time during the budget period may properly form the basis of the manufacturing budget, with all expenditures dependent on this. If, however, the concern works to customer's order, or is largely influenced in the exact amounts of different lines or styles that it manufactures by the day-to-day demands of the market, it is probable that the manufacturing schedule must be worked out in terms of units of material or of cost The manufacturing budget must be determined not alone from the estimated sales, but from the requirements of the manufacturing departments. That is, the attempt must be made to run the plant on as even a keel as possible the year round, and the manufacturing budget must be developed with this in mind, as well as the sales-department estimates and the financial requirements of the plant. The unit costs of production under varying amounts of production need to be closely studied by the manufacturing executives in order that they may intelligently make recommendations concerning the spread of the manufacturing program over the course of the budget period. They must be in close consultation with the purchasing agent, who, through his knowledge of the state of the material market, should be able to advise intelligently with regard to the probable trends in material costs, and with regard to the advisability of tying up large amounts of the firm's capital in material, partly finished or finished product, on which return will not be secured for some time.

The estimated payroll can best be determined on the basis of the prospective production by carefully analyzing past payrolls at various points of production, and from these figures making allowances based on changes in wage rates or in production effectiveness. A consideration of additional payroll costs due to overtime work, or to the necessity of adding to the overhead, will often serve as a means of stopping sales-expansion programs which otherwise look good, with the additional costs of manufacturing to reach that program eliminated.

Among the factors which assist the manufacturing department in working up their budget are the following:

1. Development of supplementary products which will make possible a balanced production, fully utilizing equipment;
2. The desirability of manufacturing or purchasing components; facilities for storing materials; and
3. A consideration of production costs of varying outputs.

The attempt to balance production frequently grows out of a budgetary analysis. This is an important managerial problem not solved in many cases. Supplementary products are not available in all instances. Producing for stock during slack periods is another outlet. If the problem is not solved the budget will keep it ever before the management.

Last, but by no means least, in the manufacturing budget is the factor of costs at various productive levels. In fact, efficient budgeting of production calls for a series of budgets at various productive levels. It is, in other words, *a step budget* rather than a single budget for a given quantity. This phase of budgetary control is possibly its greatest contribution to efficient management. It forces the persons responsible for decisions to think through the problem before it arises and thus insures prompt action when the budget is used effectively.

Service department estimates. The budgets of the various plant service departments, such as traffic, shipping, and stores, may be included in the general manufacturing budget, or they may be developed separately, inasmuch as, like other service functions of the factory, the amounts of outlay are more or less constant, regardless of the manufacturing program. Although certain phases of maintenance and other services are relatively constant, other phases are closely related to productive hours worked. The roof will need repairs and the buildings will need paint even though production may approach zero; however, the maintenance of machinery, sweeping of floors, and many other items can be made to approach the productive output. The budgets of the general business service departments, such as the general office and the personnel department, should be capable of close estimate and easy of preparation by the heads of these respective functions.

The financial budget. The financial budget cannot be prepared until the other major departmental budgets are in a fair way toward completion, inasmuch as it is directly dependent upon them. The foregoing statement is true where the company is in a sound financial position and has ample credit facilities. There are situations in which the financial position may dictate all other budgetary programs. It might be desirable to increase the inventory of finished goods but this could not be done unless funds could be secured to carry the additional inventory. The financial budget should include a statement of the probable cash income and expenditures by months, and a careful analysis of the times at which the company will be compelled to borrow in order to carry on its manufacturing program, as well as the times when it may be expected that the loans will begin to be repaid, and the times at which they may be completely repaid. The credit man of the organization will have a direct interest in the preparation of this information, and it will be his advice concerning collections that will make possible the translation of the items

of shipments into receipts at a later time during the budget period In order to be able to estimate receipts, he must be in a position to know the general credit situation and how money may be expected to come in. He must be able to advise concerning the terms of payment that will have to be permitted, and the extent to which it may be expected that the regular terms will be lived up to. In addition to this, he must be able to advise the times at which overdue balances will be liquidated. This information will largely give the basis, together with the sales department estimates, of the expectancy in receipts. From the other budgets, cash outlays must be determined through a consideration of such separate items as materials, direct labor, overhead expenditures, administrative and selling expenses, state and Federal taxes, fixed charges, and betterments to the plant. With the close analysis of all these items will come the possibility of the formation of prospective balance sheets for various times during the forthcoming budget period.

Length of the budget period. Although the length of the budget period cannot be stated definitely for all industries and all plants, care must be taken, particularly in the beginning of budget development work, that the period does not extend beyond the time of reasonably accurate forecasting. It is necessary to make some arrangements for periodical revisions in the budget, for reasons which are apparent, but which will be briefly referred to shortly. The decision concerning the length of the budget period must be dependent partially on the extent of information which is available concerning past operations. As budgets are prepared, and actual performance statistics are available to check against estimated figures, the length of the budget period may be increased. Some automobile manufacturers have a master budget covering the anticipated operations for the ensuing year's model. This master budget is broken down into quarterly or a three-months' operating budget which is the basis for some of the major purchases. The quarterly budget is broken down into detailed operating budget of one month or, during slack periods, to ten-day releases. The quarterly budget is revised at the end of each month in the light of current performance. Such a budget is in reality a step budget that is carefully controlled in keeping with current performance.

General business conditions, that is, whether business in general is stable or greatly unsettled, will also influence the length of time that the budget estimates should cover, and the number of revisions that must be made. In different businesses, the differences in the length of turnover of moneys and the importance of the seasonal factor will partially determine the length of the budget period. It should always be long enough to cover at least one complete cycle of operations, pro-

vided seasonal features and manufacturing to stock in anticipation of later sales are important factors in the business.

Action to be taken on the basis of the budget. Budgets are very largely valuable in proportion to the extent that they are used as the basis of action within the business. The general administrative control which is implied through the development of a budget implies that similar forms of control will be carried through the whole business in each department. The *success of the budget* is, therefore, *largely dependent on the extent to which each of the various departments has its work scheduled and analyzed.* Thus, on the basis of the approved budget, the financial department goes to the banks and makes arrangements with them concerning the borrowing of funds to carry on the program which has been adopted. The sales department sets quotas for their various lines, for their various branch offices, and for their various salesmen, and lets advertising contracts to the amounts specified in the approved budget, with a view to creating consumer demand which will enable it to sell the amount of each product that it has pledged itself to sell. The production department sets up general schedules of production, determines the activities of the various manufacturing departments at various times, and makes arrangements for the proper routing and despatching of the work through the factory in order that the basic schedules may be met. The extent to which such careful departmental planning is carried on will be the measure of the success achieved in the whole idea of general administrative control. For instance, upon the effective setting of maxima of articles of stores may depend the accuracy with which the budgeted amounts of inventories will be reached and, therefore, the success of the whole financial plan that has been developed.

Budgets, to be useful, must be flexible. As previously stated, if budgets are actually to control, rather than become a hoped-for ideal, they must be made flexible and elastic to meet variable conditions that may occur during the budget period. There are always some factors of the future that are incapable of being forecast at the time when the budget is prepared. These factors include minor changes in general business conditions, although major swings of the pendulum should be capable of being visualized, and changes in consumer demand. Changes in consumer demand may be basic, as a change in the type of material in a fabric, or they may be style changes which change the patterns, colors, or weights of a fabric. Changes in sales and production schedules may have to be made on account of the unparalleled favor that is given, without warning, to one particular item of line or product.

Advantageous developments which follow the use of the administrative budget. All the aims of the budget are achieved through the developments which always follow logically upon its adoption. There

is immediately secured an unheard-of co-ordination of departments, particularly a co-ordination of the sales, production, and financial forces. This co-ordination not only can be made general, applying to the activities of the business as a whole, but can be reduced to a consideration of particular lines and items. Departmental schedules can be set up which will detail the lists of expenditures, with their relation to the various items of product, as well as to the business as a whole. Costs can be collected in a way that will mesh with the developed budget, and they may be used as a means of control, which is their logical field, rather than as history. Finally, a financial program may be developed which will act as a chart to the pilots of the enterprise.

Limitations of budget control. Budgeting for administrative control has certain limitations which must be frankly recognized if disappointment from its use is to be avoided, and if the benefits that may be derived from it are to be secured. In budgeting, it is a slow process to approach perfection, a process that involves trial and error. The more frequent the trials, the fewer will be the errors. This must be understood by all executives, major and minor, or the budget plan is likely to fall into disrepute. Even if the budget figures are not capable of being fully lived up to during the first few years, the advantages gained from a careful consideration of all factors influencing the trend of the business, and the advantages of having the major executives sitting around with each other, with all the cards of their various departments on the table, should not be overlooked.

It must be understood thoroughly that budgeting cannot take the place of adequate executive control of operations, but is only an aid toward this. The effectiveness of the budget is directly dependent on the effectiveness of administration within the several departments. It is an influence which should lead to better executive control, but can never replace it.

CHAPTER XXXVII

OPERATING THE BUDGET

Reports to the general manager form the basis of his control of expenditures during a budget period. He should have information available at all times regarding the percentages by which each department is above or below its quota. If the operation of the budget is to be effective, he should question constantly with *wisdom* and *understanding* the figures that are appreciably out of line in either direction. Department managers must maintain similar checks on operations and expenditures within their departments If department budgets are controlled effectively, there will be but little need for action on the part of the general manager or his budget officer.

An alternate budget may be prepared at the time that the budget is adopted, and may supersede the one that is rendered out of date by changes in conditions. Such flexible budgets may be prepared departmentally, and, without further word, if departmental activities vary by certain percentages, the departments know the percentage by which they should increase or decrease their expenditures. If the costs of basic materials or of direct labor vary by specified percentages, definite predetermined authority may likewise be given the production departments to increase or decrease their expenditures in definitely stated proportions, and similar authority may be given the sales department to vary their estimated receipts from sales. It is at times more practical, however, to call for revisions of the budgets when basic conditions change.

The Budget Officer. The foregoing discussion implies that the general manager or another major executive is in charge of the budget. Regardless of the title of the officer or committee nominally in charge of the budget, the major executive officer is in reality the responsible budget officer. Good organization may necessitate the delegation to others of many of the routine phases of budget construction and operation, yet in the final analysis its success or failure rests on the shoulders of the chief executive officer. The actual amount of time that must be given the budget by the chief executive will depend largely upon the efficiency of the operating units and his immediate subordinates. This situation

is a good illustration of the *principle of exceptions in management.* When the operating organization functions smoothly the major executive devotes his time and energy to the formulation of basic policies and the study of conditions and principles upon which to base these policies. When things go contrary to expectation the chief executive must use his superior knowledge and understanding to adjust the functioning units or to revise the standards for operating.

The actual titles of the persons directly responsible for the supervision of the budgets in 93 companies surveyed by the National Industrial Conference Board are given in the table below:

TABLE 14

TITLES OF EXECUTIVES IN CHARGE OF BUDGETS * AS REPORTED BY 93 COMPANIES

Number of Companies	*Executives*	*Number of Companies*	*Executives*
27	Comptroller	1	Statistician
24	Treasurer	1	General Auditor
7	President	1	Superintendent of Plant
5	Assistant Treasurer	1	Comptroller of Budget
4	General Manager	1	Budget Director
3	Assistant Comptroller	1	Budget Control Officer
3	Secretary	1	Manager Control Department
3	Budget Supervisor	1	Manager of Forecast and Analysis Department
2	Assistant to President		
2	Vice-President	1	Cost Manager
2	Auditor	—	
2	Factory Accountant	93	

* National Industrial Conference Board, *Budgetary Control in Manufacturing Industry,* National Industrial Conference Board, Inc, New York, 1931, p 38.

It is not surprising that the comptroller and treasurer are named so frequently as they appear in the table above. Both of these officers have access to many detailed records that are essential to effective budgeting. Both are likely to approach the budget more from the standpoint of records than of the fundamental conditions out of which the records grew. This fact has caused much friction in many organizations. Such friction may be reduced by the use of an advisory budget committee composed of men who really know the operating conditions. The National Industrial Conference Board in its study found that out of 95 companies reporting, 38 used budget committees.[1] Although this number is some-

[1] National Industrial Conference Board, *Budgetary Control in Manufacturing Industry, op. cit*, p. 40.

what less than half of those reporting, it is nevertheless significant. Budget committees, made up of operating executives, are valuable aids to budget officers in at least two major ways, namely, (1) to furnish technical information necessary for intelligent interpretations of accumulated records, and (2) to direct and support the budget officer in formulating and carrying out the budget.

Basis for Budgetary Control. The basis for operating control through the budget is laid in the original construction of the budget itself. *Adequate accounting procedure must be provided to supply current data relative to the performance of each budgeted unit.* The organization must have been developed to the point that a specific person is charged with the responsibility for the performance of each departmental or divisional budget. Unless this has been done it would be better to postpone any attempt at budgeting, for confusion and overlapping of responsibilities are certain to arise. *Estimated costs of operating the major divisions must have been set up in keeping with expected sales volumes.* In large corporations, and even in smaller ones, provisions may be made for constructing monthly a balance sheet to compare with the budgeted balance sheet. The important factor is that provision be made in the original construction of the budget to provide the necessary tools for control.

Control of departmental performance. Each department head must make plans to have his subordinates work toward the budget in a routine way that will require but little supervision from him. The accounting department should set up a budget accounting procedure which will provide an account for each budget allotment, and then post expenditures under that allotment to that account. (See Fig. 135.) Such sheets as that illustrated should be checked constantly by a budget clerk in the accounting department, and this clerk should notify department heads when allotments seem to be in danger of being overdrawn in the future through any excess expenditure at the moment. Department heads should check over such sheets, or summaries of them, at frequent intervals, and check them against the departmental budget.

It should be kept clearly in mind that this checking is not merely a negative control. It is for the purpose of aiding in a positive control. All too often budgetary operative controls are reduced to negative checks which tend to break down morale and bring the entire movement into disrepute. When properly operated, they provide a goal to reach and stimulate morale. Action on new programs should not be taken by any department unless it is assured that the budget will not be endangered.

Construction and other activities in which it is difficult to predetermine costs with accuracy must be checked more closely than normal manufacturing operations. Figure 136 illustrates a form for checking the

BUDGET LEDGER

Year________
Item No.________
Authorized________

DESCRIPTION________________________

CREDIT			Balance Unappropriated
Amount Approved Per W O Request	C O or W O Number	Remarks	
	Brought Forward		
	Forward		

FIG. 135.

DEPARTMENTAL
DIVISION.......................................

ESTIMATE NO.......................................
BUDGET ITEM NO.......................................

	TOTAL	LABOR	MATERIAL	TRANSPT	COMM	SUB ORD.
ESTIMATE						
Jan.						
Feb.						
Mar.						
Apr.						
May						
June						
July						
Aug.						
Sept.						
Oct.						
Nov.						
Dec.						
TOTAL						

FIG. 136. Control Sheet for Use in Operating Budget.

several items in construction costs, by months, against predetermined estimates. Trends can be determined quickly from such a record.

Control of development expenditures through the use of the budget. Research and development are phases of business activity which have become increasingly important in recent years. The exact amount that can be allocated to research or development is determined by several factors, such as: the relative competitive position of the products, the available funds, the youth or maturity of the industry, the position in the business cycle, etc. Few expenditures are more difficult to predict than allotments for research. The executive in charge of development and research is required in his original request to set forth in as much detail as possible what he hopes to accomplish, how long he estimates it will take him to achieve his goal, how much money he estimates will be required, and the expected results should his endeavors be successful. All expenditures on a given project are charged against this particular undertaking. The executive in charge of research is notified monthly regarding the budget standing of his research. In turn, the director of research at stated intervals reports his progress to his superiors, both as to the time element and as to the degree of success in his endeavors. When it becomes evident (as is so often the case) that the original allocation of funds will not be adequate to pursue the research to a successful conclusion, the director of research should notify the budget officer and his immediate superiors. He should report progress to date and file a new request for funds to complete the project if he thinks that such expenditures are justified. The budget committee and the management then has to decide whether finances permit further expenditure at the time, whether other researches must be deferred, or just what to do with the available funds.

Control through the Sales Budget. The essentials of control through the sales budget are basically the same as in the case of the production and other budgets. Sales by salesmen, territories, and products are compared with estimated sales for the period such as a month. These are summarized for the benefit of the major executives. The sample report given below is illustrative of the type of information that should be provided the salesmanager and other major executives (Table 15). The salesmanager is also interested in similar reports for the various regions and individual salesmen. He is also interested in the sales by-products. If a given territory is falling down the salesmanager tries to determine the cause and may send special assistants to the region to aid. If the failure is caused by a drought or other economic reason, analysis may show that some other region is profiting because of the misfortune of the drought area. Additional sales effort in the fortunate area may well make up in part the unavoidable loss in the drought region.

TABLE 15

SALES DEPARTMENT BUDGET FOR OCTOBER
26 WORKING DAYS

Income and Expense Accounts	Budget	Actual	Variation	Per Cent of Variation
Sales at list price	$200,000	$210,000	$ 10,000	+ 5%
Salaries, executive and clerical.	$ 4,200	$ 4,000	$− 200	− 4 76%
Salaries, salesmen	4,000	4,000	0	0 00%
Commissions . . .	3,800	3,600	− 200	− 5 26%
Travel	700	770	+ 70	+10 0 %
Advertising	6,250	6,250	0	0 00%
Other expenses	800	750	− 50	− 6 25%
Trade discounts.	6,800	7,000	+ 200	+ 2 94%
Department expense for month	$ 26,550	$ 26,370	$− 180	− 0 68%
Nine preceding months . . .	295,700	294,000	−1,700	− 0.58%
Ten months to date . . .	$322,250	$320,370	$−1,880	− 0 58%

Some budget officers, in addition to rendering special monthly reports similar to the one above, express the same data graphically. Graphic representation is especially helpful in portraying trends.

Control of labor costs. Because of the difficulty of entering into term contracts that will give labor costs on any product or for any department, it is in labor costs that budget control is most difficult. Increases in salary must be given at the proper time to salaried employees, and employees resign and the person who is hired does not receive the same rate. Incentive wage systems make easier the predetermination of wage costs, and yet exact wages cannot accurately be predetermined. A variation of a few cents on the jobs of a number of workers for a number of days will make a great difference in labor costs over a budget period.

Labor budgeting is an essential element in the budgets of every department in a business. In order to predetermine costs over a period, it is necessary that some estimate of personnel costs be made. The payroll budget must show the number of dollars that will be applied in wage increases, in the savings incident to high-cost workers leaving and their places being filled with newcomers at lower rates. This is one of the most difficult items in budget preparation, and it is even more difficult to administer it within the limits that have been set down. Departmental executives must distribute the budgeted payroll in such a way that total labor costs for the department will be within budget estimates, and at the same time wages must be changed to conform to daily require-

ments. The departmental head must have his estimated payroll and his actual payroll constantly before him for comparison.

The personnel department must secure the labor budgets for the several operating departments, and make arrangements to have the necessary number and type of personnel available at such times as the prospective manufacturing schedule indicates is necessary. Sufficient personnel must be hired to provide for the high mortality rate that occurs, even under the best conditions, immediately after hiring, and such personnel must be available in time to be trained when needed in the schedule.

The modern labor budget will include such items as workmen's compensation costs and employees' insurance programs, and when sufficient experience is available, unemployment insurance costs may be budgeted.

Major business control. As the budget period progresses, the general manager must have accurate reports of operating conditions within the business. It is on the basis of these reports that changes in the budget will be made. Periodic reports, monthly or semi-monthly, will inform him of the profits and sources of profits within the last period. These reports will be compared with past periods, and with the budget. Such reports will include a statement of earnings, operating expenses, and profits for the month. An income statement will be included which will be divided into budget accounts. Major expense headings will be given for each department, with comparisons with the budget. It is difficult to visualize how modern business could be controlled with understanding and constructive foresight without the budget. When margins of profit are large accuracy in control is not quite so essential. Today the difference between profit and loss is frequently dependent upon the accuracy and comprehensiveness of budgetary control.

Current analysis of business conditions. With the reports before him, the general manager may call his advisory committee to consider the major trends which they indicate. On the basis of their knowledge of business conditions, and that of any statistician or other advisory man who may have knowledge of business trends, decision is made as to whether the budget shall continue as adopted for the remainder of the period, or whether changes or a whole new budget shall be made.

Various economic services are now available to assist in forecasting business conditions. In addition to the commercial services, some of the more important sources of information are the statistical data of the Federal Reserve Banks, the forecasts of the several university bureaus of business research, and independent statistical studies of business cycles.

The successful operation of a budget depends, above all, on successful control of the various departments of a business: sales, production, finance, and their several divisions.

CHAPTER XXXVIII

MANAGERIAL CONTROL THROUGH COSTS

The yardstick by which operating effectiveness must be measured is the cost of performance. To this end the science of cost accounting has striven, and has provided data which may be utilized as a large portion of the basis of operations. Business tragedies which have resulted from attempting to operate without a developed cost system have demonstrated the necessity of cost collection and analysis to the complete satisfaction of the manufacturing community. Cost accounting has developed as the companion science of management and as the staff on which management must lean for many of its most important decisions. The highly developed technique of cost accounting cannot here be given adequate attention. Such consideration must be left to texts on cost accounting. We are concerned with costs as an instrument of service to the manager, as a means of reaching operating decisions, and as a guide in control.

Though cost accounting forms the soundest groundwork for information on which management decisions may be based, and profits insured, like other business methods, it is not an aim in itself. It is of value only in so far as it aids in operations and in the making of intelligent executive decisions that will promote the healthy advancement of the business. No cost system, however elaborate, can itself insure these decisions or this advancement. Cost reports, regardless of their value, are inanimate and cannot themselves make improvements or insure intelligent operation. They must be studied by the executives and translated into the action toward which they point. They give the information for control, but they cannot themselves do the controlling. Cost reports must be on current periods if they are to serve for management control, in order that action may be immediate and in order that the business ship may be steered around the reefs which the reports have indicated to be immediately ahead.

In order to serve as the basis for management control, it is essential that the cost system be developed with a view to its utilization primarily for that purpose. In order that management control may be sound and the business be guided into safe channels, there are some fundamental ideas concerning the utilization of costs for guiding operations which must be understood. Since many students of industrial management

have not had the advantage of a formal course in cost accounting, a few of the elementary concepts will be presented in this chapter.[1]

The position of the cost accounting department in the organization. Fundamentally cost accounting is a functional division of the regular accounting department. It is fully realized that the cost accounting group is by no means always found in this relationship. In actual practice the cost accounting department may be found under the methods or standards department; under the production control division; under the plant superintendent, general manager, or some other important official. A consideration of the personalities involved or the capacities of the regular accounting division may be the determining factor in locating this important section of a business. At the time of the establishing of cost accounting as a separate function there may have been good reason for placing the cost work somewhere other than under the regular accounting division. Tradition and the momentum of an early start may keep up this separation long after the original cause has been removed. Good cost accounting requires a thorough knowledge of production processes (not necessarily a technical knowledge) which often is lacking in the regular accounting section. This factor is frequently the determining factor in locating the cost accounting department.

Elements of cost. Materials, labor, and expense are the simple elements from which costs are derived. Materials may be divided into two general classifications, direct materials and indirect materials. *Direct materials* are those items that go into the product and can be directly traced to the product. *Indirect materials* are those materials that are necessary in the production process but are not directly used in the product itself, such as coal, oil, and sandpaper. Certain other materials that go into the product but are difficult to trace to a given product are often classed as indirect material, such as nails, glue, putty, and in some instances, paint. The same material for one producer may be a direct material and for another, an indirect material.

Labor is also classified into two groups, direct or productive labor and indirect or non-productive labor: [2] *Direct labor* is capable of being allocated to a specific product or products while indirect labor cannot readily be thus allocated. The method of wage payment may influence

[1] It is highly recommended that all young men entering business study accounting at least through Introductory Cost Accounting The fact that many of our successful managers today have not done this is no argument to the contrary. These successful men have acquired the fundamentals of accounting the long, hard way. Experience is a good teacher but often an expensive one.

[2] Productive and non-productive in a sense are misnomers when applied to labor, although they are in common use. All labor should be productive or abolished. The mere fact that labor may not be directly traceable to a given product does not mean it is non-productive in the strict sense of the term.

the classification of labor as direct or indirect. A janitor is ordinarily paid on a day-rate basis and his work is usually classified as indirect. In some departments the entire group, including the janitor, may be paid on a group piece-rate basis. In this case the janitor service is directly allocable to the product and therefore is classified as direct labor.

Another group of items entering into costs is known as *overhead expense or burden.* Depreciation, interest, rent, taxes, heat, light, and power, etc. are just as much a matter of cost as materials and labor. Expenses may also be divided into two classes, fixed or constant and variable or fluctuating expenses. *Fixed expenses* are those costs that tend to remain relatively constant regardless of the volume of production, such as the interest on bonds, taxes on land, buildings, and equipment, depreciation arising from the passage of time, rent, etc. *Variable expenses* are those items that tend to vary with the volume of production, such as depreciation arising from use, royalties paid on a volume basis, power, salaries of minor clerks and some sub-foremen, etc.

Classification of costs. Costs may for convenience be classified as follows:

1. Prime costs = direct labor costs + direct material costs.
2. Factory costs = prime costs + factory expense.
3. Production costs = factory costs + general expense.
4. Total cost = production costs + selling expense.

To make the series of equations complete it would be well to add another one:

5. Selling price = total cost $\pm$ profit or loss.

Factory expense is composed of all those burden items which are capable of being allocated to the factory, such as waste, depreciation, repairs, taxes, insurance, indirect labor, power, heat, light, salaries of factory supervisors and clerical workers, etc.

General expense includes general administration and managerial costs, such as general office salaries and expenses; legal costs; that portion of power, heat, light, depreciation, etc , that are chargeable to the central office group; accounting; and other items such as communication expense, general office supplies, and in some cases institutional advertising, public relations expenses, etc.

Selling expense includes those items that are directly chargeable to selling. The exact breakdown of this expense, like all the others, may vary with the individual concern and the use made of the costs. Advertising, for instance, is frequently chargeable with little difficulty to sales, yet some institutions classify this item under general expense.

Rent, interest, and taxes. In a strict economic sense there may legitimately be some argument about classifying rent, taxes, and interest as expense items. From the managerial point of view these expenditures are a real charge against the business enterprise and as such must be paid out of revenue or capital in case the revenue is not large enough to cover all outlays. Regarded in this light, they are in a very real sense expenses.

Distributing factory expense. Products resulting from the production process may for convenience be classified into four groups, as follows:

1. The primary product.
2. By-products.
3. Joint products.
4. Waste.

The primary product is the simplest classification and may be readily recognized as the main product which the enterprise is designed to produce, such as steel in the steel mill and fabric in the textile mill. A by-product is a product resulting from the production of a primary product. It has considerable value in totals, but its production is purely incidental to the major product. Coke is a by-product of the steel industry. By-products in the past have often been ignored. Even today items that might well be marketed as by-products are often ignored unless the total volume is large. For instance, small packing-houses frequently do not have the full line of by-products that the large packers have. When two products resulting from the same production process both have considerable value within themselves, they are known as joint-products. Illustrations are common in everyday life, such as butter and buttermilk, meat and hides, cotton and cotton seed, coke and artificial gas, etc. The relative values of two joint products are usually closer to each other than is the case of a by-product and its primary or major product. Waste may arise from the manufacture of a major product, joint products, or a by-product. Waste has relatively little value and in some cases may have a negative value in that it costs money to get rid of it.

From a cost standpoint, a primary product carries all costs that can be allocated to it. All costs incurred in processing the by-product after it is separated from the major product are naturally chargeable to the by-product. If the competitive situation for the major product is keen the sales price of the by-product minus all costs allocable to the by-product is frequently subtracted from the cost of the major product in figuring the cost of the major product. In an effort to find true costs this practice may be followed anyway, but it is almost certain to be done where margins are low and competition is keen. In the case of

joint products, all costs incurred after the two products are separated are usually allocated to the respective products. The costs of the two products up to the point of separation are often divided between the two products on the basis of the total sales values of the two products. The cost of saving the waste is naturally charged to the waste. The recovery value is usually so low that no special effort is made to tie it into the cost of the product from which it is derived.

The distribution of factory expense is a complicated matter even for a major product and becomes increasingly so for by-products and joint-products. Absolute accuracy is not possible, but accuracy for managerial control is attainable. To illustrate some of the methods used and some of the difficulties involved, a few of the bases for distributing factory expense are presented below:

1. Distribution on the basis of direct labor. Direct labor as a basis for distributing factory burden is approached from two angles: namely, direct labor hours and cost of direct labor. These two approaches would give the same result in a situation in which the men were paid at the same rate on a time basis. Such a condition seldom prevails; hence the two systems are usually different. The distribution of expense on the basis of direct man-hours worked on a given product is predicated on the assumption that these expenses are proportional to the man-hours worked. The system is a simple one, and it is probable that its simplicity may account for its wide use. When the rates paid the workers are relatively the same and the size and character of the work varies only slightly, this system is accurate for most purposes. It has the advantage of emphasizing the time element in the distribution of indirect costs; however, it emphasizes only "worked time" and does not consider "elapsed" time, which is also an important item in costs. This system does not differentiate between the different kinds of equipment that may be used in processing work possessing different characteristics. It is self-evident that a carpenter working with hand tools is not in fact carrying as much burden as a man working on a large boring mill in the same department.

Distribution of burden on the basis of the cost of direct labor is a modification of the direct labor hour basis described above. Where the rates differ materially in the department, the results of the two systems will be different. The direct labor cost basis of distributing expense is predicated on the assumption that burden is proportional to the direct labor cost. This system ignores the influence of elapsed time and does not emphasize the time worked quite so definitely as the direct labor hour basis. The other advantages and disadvantages of the cost of direct labor basis are essentially the same as the direct labor hour basis. It does have the advantage over the direct labor hour basis in that it is expressed in terms of dollars and cents data, which are accumulated for

other purposes and need not be specially segregated in the same sense that labor hours have to be collected.

2. Prime cost basis. Prime costs are equal to the sum of direct labor costs plus direct material costs. Burden distribution on the basis of prime costs is in reality a combination of the system described above and the "direct material cost basis" described below and possesses both the advantages and the disadvantages of each. This system has not met with widespread acceptance.

3. Direct material basis. The distribution of expense on the basis of direct material is predicated on the theory that indirect costs vary in direct proportion to the direct material used. This system is a logical one for a continuous process manufacturing a standardized product. If more than one line is in use turning out products that are materially different or if the same line turns out different products, this system tends to be less applicable. It is of doubtful value for burden distribution for an industry producing a variety of products.

4. Machine rate as a basis for burden distribution. In an attempt to allocate factory expense, it is but natural that consideration be given to the individual machine or group of machines as a basis.[3] This method has been in use in a general way for a long time. The machine rate basis of expense distribution in its more highly developed form strives to allocate to each machine its true expense when considering all costs such as original cost of machine and expected life, power consumption, heat, light, floor space occupied, maintenance, etc. By carefully estimating the expected use of a machine and dividing all costs allocable to this machine for a given period by the total number of expected-use hours, the burden charge per hour can readily be obtained. By keeping a record of the time a given product uses a machine, the burden cost of each machine can be charged to the product. This method involves considerable record-keeping, but it is theoretically preferable to many of the other systems. A failure to use the machine the anticipated number of hours leaves a portion of the burden undistributed while a usage of the machine in excess of the estimated time will distribute burden greater than is factually justified. Again, if a machine larger than necessary is used for a given job because machines of the proper size are overloaded or broken down, the particular product thus processed will be charged more than it should ordinarily be. It is true that these shortages or excess charges may be accumulated over a period and adjustments made, but it is not so easy to make these adjustments for an individual product in a jobbing shop. Individual costs including either excesses or shortages in

[3] See Dexter S. Kimball, Principles of Industrial Organization, McGraw-Hill Book Company, Inc., New York, 1933, pp. 307-313.

burden distribution are particularly undesirable when they are used later for estimating purposes.

5. Production centers as a basis of expense distribution. The production center method of expense distribution is a logical expansion of the distribution by machine method and eliminates most of the objections of the machine method. A given production center may or may not be separated by aisles or partitions. It does, however, have definite boundaries and may well be thought of as having a special room for each center. All the charges for this particular center, such as floor space, repairs, heat, light, power, maintenance, can be allocated to the center as a unit. These total charges are then distributed over the total product moving through the center on a time basis. This system is theoretically sound, but it requires a great deal of careful work to establish correct rates for each center. The same item of overcharges and undercharges arises as in the machine rate basis in cases where the production center has less or more production than was anticipated for the given period. Excess charges because of using a larger machine than is needed are less likely to occur under the production center method of expense distribution than under the machine basis because the production center will usually include both machines.

Combination of methods of burden application.[4] In cost accounting as in other phases of managerial control the system should be adjusted to the needs of the situation. Two or more systems may logically be used within an organization when they best serve the requirements of the enterprise. In one department practically all the production may be machine work, and the basis of burden distribution may well be by the machine-hour method or the production center method. In another department of the same enterprise most of the work may be hand assembly either on benches or on assembly line. In this department, the direct man-hour or cost of direct labor basis of burden distribution may well be the best one to use. In a department where there is a large amount of both machine work and hand work it may be advisable to apply machine burden such as power, depreciation of machinery and equipment, repairs and maintenance of the machines, and insurance and taxes on the machines, by the machine-hour method; and at the same time distribute burden arising from supervision, welfare expense, heat, light, and other items that apply more intimately to the workers than to machines, on the direct labor cost basis.

Use of cost information. It is evidently poor economy to collect cost data and not use it. There are at least two important uses of cost information; namely, for control of operations and as an aid in price

[4] See Chas. F. Schlatter, Elementary Cost Accounting, John Wiley and Sons, Inc, New York, 1927, pp. 269-271

determination. In the short run, competition may be the determining factor in price. Even in the long run, competition may set the upper limit of price, but the long-run lower limit of price under competitive conditions tends to be determined by the cost of production of the representative firm in placing the goods on the market.[5] Current costs influence price largely through serving as a signal to indicate whether or not operations are profitable at a given price. For a time it may be better business to continue to sell at a price which does not recover all burden costs rather than not to sell at all.

From the standpoint of the industrial manager of a factory, costs serve as a chart for control. When standards have been accurately established, a failure to meet these standards is a signal for managerial attention. To be effective in control, the cost system must be so organized that costs can be allocated in such a manner as to coincide with areas of responsibility. It is a waste of time for control purposes to send a foreman a cost report showing an increase in the cost of production arising from conditions over which he has no control. The responsible executive should be charged only with those costs over which he has reasonable control. The foregoing statement raises the question of the disposition of the excess unit burden costs arising from a decrease in the volume of production. It is self-evident that the enterprise as a whole must bear all costs whether or not they are currently recovered in the selling price of the product; however, it does not follow that the individual department must be charged for control purposes with all costs. If the department is not charged with all the expense, how should the undistributed burden be handled? One method is to establish a burden charge for each department for an expected normal volume and to use this charge as a basis even though production may fall below this norm.[6] The excess burden would then be charged direct to profit and loss as a charge against management rather than the individual department. This or a similar program is incorporated in standard costs which will be discussed later in this chapter.

Depreciation

General. In the manufacturing cycle, labor is added to material with the aid of buildings and equipment to produce a finished product which is sold to the consumer at a long-run price equal to all costs incurred plus a normal profit. (Profit is here used in the business sense to mean the return to the owners after all costs have been met. Profit in a cor-

[5] See Paul F. Gemmill, *Fundamentals of Economics*, Harper and Bros., New York, 1935, pp. 440-459.

[6] In substance this was the method advocated by H L. Gantt in his article in the *Journal of the American Society of Mechanical Engineers*, August, 1915.

porate organization may or may not be distributed to the owners, but it is out of profit that any returns are made to the owners unless a portion of the original capital is returned.) One of the costs of production that goes into the product just as truly as material or labor is the loss in value of the buildings and equipment. Fixed assets are constantly being converted into expense which must in the long run be recovered in selling price in order that the buildings and equipment may be repaired during their effective lives and replaced when they are no longer economically usable.[7] This expense arising from the conversion of fixed assets into the product sold may take several forms, such as wear and tear, and physical decay resulting from the passage of time, obsolescence, and inadequacy. Inadequacy in and of itself may not in a strict sense be an expense, but it certainly lessens the value of the item to a going concern, and thus gives rise to excess expense in case the equipment is forced to do work for which it is not large or powerful enough. Again, inadequacy on the part of equipment may compel the purchase of adequate equipment, an expenditure which would not be necessary were the equipment adequate.

Obsolescence. Obsolescence is a term used to describe equipment that still has useful productive life for the purpose for which it was originally intended, but which is no longer economical to use because of the development of newer types of equipment, new processes, or new inventions. Obsolescence differs from inadequacy in that obsolete equipment has little or no value save for scrap while inadequate equipment may have much valuable productive life remaining. Inadequate equipment in one situation may be entirely satisfactory in another one where there is less work to be done. Obsolescence is more common in newer industries in which development of processes and product is more rapid. A basic discovery, however, in any industry may render much of the equipment obsolete. Model changes in the product may render certain tools and dies for the old model obsolete not because they are replaced by a newer tool for the old product, but because the product has changed, requiring new tools and dies. This situation is common in the automobile body industry. Systematic provision for the obsolescence of equipment is difficult, save in those industries in which model changes come at regular intervals; the special equipment is then frequently written off in a short time. It is not uncommon to find that no attempt is made to segregate obsolescence as such; it is included in depreciation by making provision to retire the equipment in a shorter period than would be justified by wear and tear arising from use or the passage of time.

Depreciation. Depreciation is the reduction in the value, or the effective economic life, of a product arising from the passage of time,

[7] Land is an exception to this statement.

use or abuse, wear and tear, influence of the elements, or the cessation of demand for use.[8] As stated above, depreciation frequently is used to include obsolescence and inadequacy or supercession.

The mere passage of time creates physical decay or decrepitude in such things as buildings, boilers, rubber products, and other productive instruments. Repairs will prolong the life of such items, but eventually they must be replaced. Wear and tear take place with use. It is relatively proportional to use; however, the time element may influence the rapidity of wear. When a factor of production is being consumed in production, regardless of the cause, provision should be made to accumulate funds out of the selling price of the product to replace the item when no longer usable.

Depletion. Certain business assets, such as coal or iron deposits, timber, clay deposits, etc. are consumed in being prepared for market. Minerals, when removed from the earth, are not replaceable. Provision may be made to replace trees but it takes a long time. Earnings from operations, such as mining, are made up of two items—profits from operations and a recovery of part of the capital investment. The reduction of the mineral deposit through removal for use is known as depletion. It may be legitimate to distribute to the owners the total income from such operations, but they should be clearly earmarked to avoid confusing a return of capital with earned income. Patent rights and franchise privileges lose their value with the passage of time and provision should be made to amortize their value during their effective lives or there will be a partial depletion of capital if the total income is distributed. Provision for depletion may be made through investing the accumulated funds in similar or other assets or a special sinking fund may be established by investing these funds in income-bearing securities and reinvesting the income so that the total amount will be available at the expiration of the item's effective life.

Methods of depreciation. Before discussing the simple methods of depreciation, it is well to consider the basis of depreciation. There are three common bases for depreciation; namely, (1) original cost, (2) replacement cost, and (3) the present value or appraised cost. There are some advocates of a fourth base, original cost plus maintenance cost.[9] This last base is of doubtful value and has not found wide acceptance. Depreciation on the basis of original cost is simple and easily determined by referring to the equipment ledger. Original cost includes transportation and installation costs. Depreciation on this basis will tend to retain the original investment intact. Some authorities argue that the

[8] See L. P. Alford, *Cost and Production Handbook,* The Ronald Press Company, New York, 1937, pp. 1215-1221.

[9] See L. P. Alford, *op. cit.,* p. 1232.

objective should not be merely to preserve the original investment but to preserve the organization as a going concern, and that this will not be accomplished by merely recovering original costs during a period of rising prices; hence they advocate depreciating the asset on the basis of its replacement cost. There is considerable merit to their argument, but its practical application involves a great deal of accounting and revision of depreciation charges as price levels fluctuate. This basis has merit when appraising an enterprise for financing and insurance purposes. It has little standing with the income tax collector and may be criticized on the basis that costs as far as possible should reflect actual rather than estimated expenditures.

The present value basis or the fair market value basis has had special standing in certain special cases involving property acquired prior to March 1, 1913, and property acquired by gift or transfer in trust after December 31, 1930.[10] It has relatively little significance in industry in general.

There are several methods of depreciation; however, a consideration of the *straight-line*, the *sinking-fund*, the *percentage-on-diminishing value*, and the *machine-hour* methods will illustrate the main purposes.

1. The *straight-line method* of depreciation assumes that the depreciation takes place in equal increments throughout the life of the equipment. The life expectancy of the machine is estimated together with its estimated scrap value. From the cost of the machine is subtracted the scrap value and the remainder is distributed equally among the estimated years of life of the machine. For instance a machine costing \$1400 having an estimated life of ten years and scrap value at the end of this period of \$200 would have an annual depreciation of \$120 computed as follows: $\frac{\$1400 - \$200}{10} = \$120$. This method gives a constant depreciation rate for each year which in reality does not conform to actual depreciation, since a machine depreciates more during the first few years of its life than during the last few years. Maintenance costs are greater during the later years of the life of a machine which, when added to the straight-line depreciation charge, will give an unequal charge against production. If it is desirable to have a relatively constant machine cost chargeable to production, the straight-line method is not satisfactory. It is, however, in wide use, probably on account of its simplicity and ease of computation.

2. The *sinking-fund* method of depreciation applies the sinking-fund principle to accumulating depreciation charges. The amount to be depreciated is found by the same method as indicated above under the

[10] See L. P. Alford, *op. cit.*, p. 1235.

straight-line method. By an algebraic formula the amount of money that must be set aside periodically in equal amounts and to which interest at a given rate is credited is determined such that the accumulated total will equal the desired amount to be available at the end of the period. This formula may be written as follows: $A = \frac{V(r-1)}{r^n - 1}$, in which A represents the annual depreciation charge, V equals the total fund to be accumulated, n represents the life of the equipment, and r equals the rate of interest plus unity, or 1 This formula may also be written $A = \frac{Vr}{(1+r)^n - 1}$. A simpler method is by the use of compound interest tables to find the amount which $1 per annum compounded at r interest rate will equal in n years and then divide the total amount to be accumulated by the amount that $1 will accumulate for the period. The quotient will be the amount to be set aside annually. To illustrate: using the same problem given under straight-line depreciation above, $1200 are to be accumulated at the end of 10 years at 5 per cent. One dollar deposited or set aside annually at 5 per cent compounded interest will accumulate $12.578 in 10 years. To accumulate $1200 in 10 years on this basis $\frac{\$1200}{\$12\,578}$ or $94.586 would have to be set aside annually. The sinking-fund method of calculating depreciation may be used even though an actual fund in cash is not established. This method of depreciation accounting is interesting in that it portrays the nature of the depreciation problem from another angle, but it has found little acceptance in industry.

3. The *percentage-on-diminishing-value* method of depreciation reduces the annual depreciation charge in that each year's depreciation is subtracted from the last year's value of the equipment to establish the new reduced base for the ensuing year. If s = the salvage value of the equipment at the end of n years and C = the original total cost of the machine, then the annual rate r to be applied to the diminishing value is found as follows: $r = 1 - \sqrt[n]{\frac{S}{C}}$. This system places a heavy charge on the earlier years of the life of the machine. This of course is exactly what the system is designed to do. It leaves an insignificant charge for the later years of the life of the equipment.

4. The *machine-hour* method of figuring depreciation is founded on the theory that depreciation is proportional to use. The estimated number of hours the machine may be used prior to replacement is taken as the base, and this is divided into the amount to be depreciated to get the machine-hour rate of depreciation. This amount is then charged

as a depreciation expense for each hour's use of the machine. This system is similar to the "service output method" of depreciation, but the unit is the hour, rather than the product The system has much to commend it, but has not received wide acceptance in practice. As a matter of fact, the *straight-line* method of depreciation is the one in most common use.

Use of Cost Data

The cost system as related to the organization of the plant. In a previous paragraph it was pointed out that cost information should be collected in such a manner as to fix responsibility for operations and to aid in long-run price determination. It is important that the relationships between the cost department and other departments be indicated in a little more detail. If new functional departments are constructed, or if development programs are undertaken, the cost system must allow computation of the savings effected through the changes. Otherwise these new departments or new work may have difficulty in establishing and holding the esteem of other branches of the business, particularly any of them that may have opposed the change prior to its consummation. Thus, if job-study work be developed, it will be most desirable to be able to balance the cost of the taking of the studies against the savings through lower unit costs on those operations which are studied. If a planning department be instituted, it should be possible to know the savings in direct and indirect labor in the factory departments which have resulted from the expenditures incident to the creation of the planning force. Such information becomes of particular value as planning work is extended, since it meets opposition successfully when the planning department has proved its value, and prevents hasty extension when conditions demand a higher degree of success with work already undertaken, rather than the taking on of new work.

The cost-accounting department should be in a position to furnish valuable statistical information, or, if there be a separate statistical department, to give this department the basic data from which the statistical information may be gathered. The personnel department should be able to gain accurate information concerning the actual cost of replacement of workers. As has been seen, this is partially dependent on the lower productivity of new workers, and the amount of spoilage which can be attributed to having a "green" operator on the job. Such information can be secured most logically from the cost records. Although it may be taken off the production records by the planning department prior to the time when these are turned over to the cost department for costing, nevertheless this is primarily a cost problem. Such studies are only samples of the way in which cost information

may be utilized to enable the organization, as constructed, to operate more smoothly. The personnel department will be able to determine the necessary care in selection for particular jobs, and to follow up the effectiveness of its own operation far more successfully, if it has such information at hand

In periods of depression when the payroll must be cut at all hazards, and regardless of ultimate cost, departmental analysis of costs which indicate savings effected under different operating conditions, as well as actual expenditures, make possible intelligent pruning of the payroll, rather than the hit-or-miss methods which are inevitable if analyzed data be not available.

Standard costs. As an aid to simplifying cost-accounting procedure and fixing the selling prices for products, one of the more recent cost developments has been the setting of standard costs. That is, the normal expenditure for material, direct labor, and overhead charges for a given product, or for a number of hours' production in a given department, is computed. This allows the elimination of much detailed cost analysis, and at the same time permits adjustment at the end of a period through the totaling of actual departmental cost during the period and comparison with the normal or standard cost. If the actual cost of a given job performed during the period be wanted, this may be secured through applying the ratio for the period between normal and actual cost of all jobs to the particular job in question. Such a system is valuable because it permits the formulation of long-run production and sales policies which are not disturbed by minor fluctuations in operating conditions, and it furthermore makes possible the separation of normal production costs from costs which are due to the position in the business cycle or general efficiency or inefficiency in the management as a whole.

If an attempt be made to secure an absolutely accurate cost on each order, a cost that shall currently absorb all overhead or indirect charges, a fluctuating cost necessarily results, and this makes difficult the determination of long-run business policies. With a plan of standard costs, prices remain fairly constant, and losses or gains in operation are directly chargeable to the general business accounts which are responsible for them rather than to the departmental or other accounts which have had no responsibility whatever for the conditions as they exist. Thus volume of business comes to be figured in terms of hours of production and quantity of product, rather than in terms of dollars of business. This is a far more accurate estimate, because the basis of dollars of business is always likely to include a more or less constant fixed overhead burden.

Under many cost systems wherein overhead costs have been largely pro-rated as business is carried on, overhead costs have not been added

in sufficient quantity when business was good, thus cutting down selling prices and prohibiting the establishment of a reserve for bad times. Similarly, they have been added too heavily in times of slight production, with the result that costs have increased as selling has become more difficult. Frequently, managers have realized the impracticability of spreading overhead over a greatly diminished product, and have charged a large share of it directly to the profit-and-loss account. They have less commonly kept their overhead up during times of prosperity, so as to create for themselves a reserve to which they might charge the unabsorbed overhead of times of depression.

Idleness expense. Standard costs have been developed with the idea of eliminating fluctuations from the selling price of products, in so far as this is practical. To secure full benefit from the utilization of this idea, a rather full study must be made of idleness expense, and this then becomes one of the primary objects of the cost system. The reports on costs of idleness give the general management much of the information with which to direct its general policies. If the plant be operating on part-time only, the cost of maintaining the portion of the plant which is idle must be either taken up in the selling price of such articles as are manufactured, or charged directly to profits. There has been much thought of "absorbing" overhead—too much for the good of general managements. Of course, overhead expenditures must be taken care of; but if they are absorbed in the product being manufactured, the causes of idleness and of the increased unit overhead charges are not likely to be brought to the attention of those who are in a position to correct them. If these charges be directly listed under some such heading as idleness expense, they will force themselves to the attention of the chief executives for correction, and selling prices can be fixed to include some of this cost of idleness or to exclude it entirely, as may be deemed wise under the prevailing conditions. This policy will be determined largely by considering whether the product can be sold in competition if the expense be added.

The system of planning, to be described in a later chapter, is of inestimable value in securing information on which to develop idleness-expense charges. The planning department is not only able to give to the cost department information concerning idle equipment, but is in a position accurately to determine the cause of the idleness. It remains for the cost department only to compute the cost of idleness and to render reports to the executives responsible. The latter may then take the necessary remedial action in an attempt to cut down or eliminate the existing idleness. A certain proportion of this will be found to be due to lack of sales, which may or may not be remediable. On the other hand, an intense analysis of the data will indicate the cost

of ineffective operation of the purchasing or inventory control, of the maintenance department, of the planning department, or of the personnel department. Of course, the necessary information concerning causes of idleness could be secured without reference to the cost department, but the inclusion of cost figures not only gives the information attention value, but allows comparison with the cost of taking steps to remedy the conditions causing the idleness.

Fixed and variable costs. Variable costs, which change almost in proportion to the amount of business done, include direct wages, direct labor, and certain types of indirect expenses, such as the salaries of minor executives who are easily dropped in times of poor business, and income taxes, which vary almost directly with business done. Fixed costs remain constant, almost irrespective of the amount of business done. These costs include not only the salaries of major executives, but interest on investment, particularly borrowed money, taxes on property, and certain obsolescence charges on both materials and equipment. Cost reports should clearly differentiate between these fixed and variable costs. Although the rendering of idleness expense reports will partially cover this field, nevertheless both the cost department and the interested executives should have in mind constantly this distinction between variable and fixed costs. Any reports that clearly separate them will be of major assistance in the formulation of sales and production policies and of administrative budgets.

During the determination of major policies, fixed costs must first be covered by receipts from sales in income computation. Thus, if fixed costs are $2000 per week, and sales are $5000 per week, there is left a balance of $3000 for the payment of variable costs and profits. Although variable costs vary with the volume of goods sold, yet for any given unit of goods they remain practically constant. That is, for 50 units they would be practically double the amount for 25 units. They vary proportionately with the amount of goods produced. The variable cost per unit may be readily determined approximately. Assume that the $5000 of sales represents 50 units of product, the variable cost of which is $60 per unit. This will give a variable cost of $3000 to be applied to the week's sales. Inasmuch as this is the exact amount remaining after deducting fixed costs from sales, it follows that the week's business was done practically at cost. If $7500 of business were done, there would remain $5500 to be applied to variable costs, which at $60 per unit would be only $4500, and $1000 would remain for profit. If $4000 of business were done, there would remain but $2000 to be applied to variable costs, which would be $2400, and there would be a loss of $400 on the week's business.

Although computations such as the foregoing can be used only by the management as approximations, still they are valuable in the formulation of major business policies; and cost statistics should be prepared with a view to their use as indicated. In most businesses, the computations will not be quite so simple as the illustrations, inasmuch as fixed costs will not remain exactly fixed, and variable costs may not remain the same per unit of product. As production increases, the variable cost per unit will be likely to decrease somewhat. Possibly some variable costs will decrease slightly. In some cases, these variable costs of different types would have to be segregated in the cost reports. Tables can be prepared which will indicate the variable cost per unit at different points in the production scale, as well as modifications in fixed cost which are likely to occur as production changes. With these data to utilize, the general management will be in an excellent position to determine general sales and production policies, athough the information thus obtained will not be exact enough for the accurate fixing of selling prices. Thus a consideration of fixed and variable cost is useful mainly as a guide-post for the formulation of major business policies.

Cost of production has frequently been the only figure shown by cost reports. Consideration of the paragraphs on idleness expense and those on fixed and variable cost will quickly indicate that, for management purposes, reports on the cost of not producing are quite as important as reports on the cost of producing.

The cost system and the budget. The administrative budget, which serves as the co-ordinating control over all operating departments, must necessarily be based on cost figures. This not only shows the necessity of keeping the cost figures up to date, and having a system of collection which will allow costs to be kept up to the minute, but also indicates the extent to which management control is dependent on costs. In making the budget, the cost records of past years give dependable information, but the current cost figures must be utilized in laying out the program for the months to come. Cost records during a budget period can be carefully analyzed only in the light of the budget which was prepared as the target. The cost record becomes the progress report on obligations fulfilled by department heads, and permits modification of operating procedure or change of business plans during the course of a budget period. This again indicates the necessity of developing cost records so that they will be comparable with the organization of the business.

The new business era is one of competition, of profits through effectiveness of operation rather than through control of some major resource or important process. Although no particular phase of sound management will alone insure successful operation; nevertheless, all operating

decisions must in the end be based on costs. Thus, accurate reckoning of costs becomes the basis on which the expediency of management steps and decisions is determined. And costs must be reckoned not only accurately, but in ways which will permit their utilization for the formulation of management policies and the execution of management programs.

CHAPTER XXXIX

CONTROL OF SALES

Although in too many manufacturing establishments the sales department has held the balance of power to the ultimate detriment of the whole enterprise, nevertheless, it is the sales department which brings the orders that allow the business to survive. Even the most effectively organized manufacturing departments will show poor results unless a relatively steady stream of orders is being entered on the books of the company. Particularly in buyers' markets, the continued prosperity of a business must rest largely on the ability and effectiveness of the sales force, and the ability with which this force is directed. As a factor in operation, the technique of sales and advertising is extremely important. However, this technique represents the findings of sciences almost as highly developed as those which govern the manufacturing organization and process, and cannot become a subject for adequate consideration here. Our discussion must necessarily cover sales only from the administrative and co-ordinating standpoints and in its relation to other major functions of a business, particularly production.

Direct control of the business over the sales function must be assumed. That is, though there may be jobbers in the scheme of product distribution, these are assumed to be links in the distributive process rather than to be in a position to control the business policy. Any manufacturing enterprise which places itself in a position where its distributors may dictate what shall be manufactured and when this shall be turned out, is in a very precarious condition for long and prosperous operation. Particularly in certain textile lines, in the past, selling agents have dominated manufacture to this extent, and a usual result has been that the manufacturing plant has sooner or later been taken over by the selling agents; after this time a policy of co-ordination rather than of dictation has been instituted. There is thus assumed, in the discussion of control of sales, a sales or a merchandising manager who shall have actual control over the means and methods of distribution, as well as responsibility to the general management of the business. This sales manager, although full of enthusiasm and drive, and with the ability to go out and get business in the old-fashioned way, must also be cool and calculating and able to plan and direct the efforts

of his subordinates, as well as to co-ordinate their efforts with those of the production and financial staffs.

Policies and Organization of the Merchandising Function

Goods are not completely produced until they have been turned over to the ultimate consumer for his use. The sales function is a very vital phase of production. In terms of the economist the selling function creates *possession utility*. At times the sales force may control not only the *possession utility* but also *place utility*. The growth in the size and complexity of present-day markets has forced management to give increasing attention to the organization of the sales force and to the formulation of policies to guide this organization.

Nature of the product. Probably no single factor exerts a more powerful influence upon the organization of the sales force than the nature of the product. The methods used in marketing California fruit differ materially from those used in marketing lumber or hardware. There are two major classifications of goods, namely, producer's goods and consumer's goods. Each has its own special problems in marketing. Between these two classifications there are many gradations. The same product may be a consumer's good in one instance and a producer's good in another use. Cloth when sold to the housewife is a consumer's good, whereas it is a producer's good when sold to the dress manufacturer. The selling organization must be constructed so that not only is the nature of the product given due consideration, but also the buying habits and customs of the purchasers are cared for.

The Nature and extent of the market. If the market for the product is national, the organization of the sales force will have to be adjusted to this situation. On the other hand, a product may by its nature be restricted to a local market and thus require a different type of selling organization. The difference in the organization may not arise out of the difference in the size of the sales force, although this may be a factor. For instance, ice cream is usually sold in a local market, whereas files and glue usually have national distribution. An ice cream manufacturer in Chicago may have ten or fifteen salesmen and a national distributor of files may have the same number, each firm performing a satisfactory service in its respective field. The market may be confined not only to a single city but to one sector of this city. The nature of the product may influence the decision and again the policy of distribution may be controlling. In some cases the manufacturer may decide to cultivate a given territory intensively while in another situation the same manufacturer may conduct an extensive sales program. Within the same area a given manufacturer may cater to two or three different markets. In

Detroit, for instance, a paint manufacturer may sell direct to the automobile producers and governmental units, and through retailers to contractors and householders. Each of the three markets may require special salesmen, a fact which will definitely influence the organization of the sales force. The custom that has grown up in a given industry may also influence the organization of the sales force and the method of distribution.

Choice of distribution channels. Both the nature of the product and the market that it is desired to reach definitely influence the organization of the sales department and the choice of distribution channel. Rarely indeed are automobiles sold in department stores, yet women's stockings always are. On the other hand, women's stockings are also sold successfully direct to the consumer. Certain products require specialized knowledge to demonstrate and sell. The ordinary retail outlet is seldom in a position to give this specialized service. Machine tool manufacturers have often found the mill supply houses unsatisfactory as outlets for their products and have sought to deal direct with the users of their equipment. This is usually an expensive method of distribution. Staple products are successfully marketed through the regular retail outlets. A large manufacturer of several products may use many different outlets for his products. The General Motors Corporation may have a separate organization selling its different cars in the same community in order to get specialized skills and keen competition for each product. In one area the manufacturer may sell through wholesalers and jobbers and in another through their own branches and warehouses, while in still another area the product may be sold through chain stores. Here again such factors as financial resources of the company, custom, the extent of the market, the nature of the product, and the special inclinations of the management may be controlling. Regardless of the motivating force, the channel of distribution selected will greatly influence the organization of the sales force.

Very closely tied in with the channel of distribution is the choice of methods used in promoting sales. This phase of the selling program involves such items as the use of personal salesmen, selling through correspondence, the use of samples, the use of advertising, and the medium to be used for advertising. These methods may be used singly or in any combination. The actual methods used will directly influence the organization of the sales department. It is evident that mail order selling or selling by correspondence requires a distinctly different selling organization from that used in house to house canvassing. If large-scale advertising is used it will necessitate a special advertising department or the employment of an outside advertising agency. Where an outside agency is used provision must be made within the employing

organization to approve the advertising in a general way, at least to see that it conforms to the over-all objectives and policies of the enterprise.

Physical organization of the sales division. The physical layout of a sales organization was formerly given relatively little attention. Competition has focused attention on this phase of merchandising along with the many other complicated activities. Today we have the traditional grocer, the super market, the self-serve grocery, and in the offing the conveyorized self-serve grocery. Each type has special features of physical layout. Many establishments have service departments or repair divisions such as the alterations department for ready-to-wear garments and the garage for the automobile sales agency. The service departments may be located in the same building and on the same floor with the salesroom. On the other hand, they are usually located in places that can not be used advantageously for selling purposes. The stockrooms or storage space involves considerable planning. In the sale of furniture it is not uncommon to have samples on the sales floor and make deliveries from a warehouse several miles away. All of these organizational problems require careful managerial planning, the successful solution of which may be the turning point between profit and loss.

The organization of the sales force. The actual organization of the sales force will be greatly influenced by the nature of the product, the desired market, the methods selected for demand creation, the distribution channels used, and various combinations of these factors. Two large department stores, however, may follow different organizational principles even though they sell the same product. The buyer may be in direct charge of the department-sales people, merchandise, displays, etc. in one store and have no direct control over the salesmen in another. The advertising department in a tooth paste manufacturing enterprise may report direct to the president and even have the sales department, a division of advertising, while advertising in most organizations as a rule is a department under the sales division. Sales promotion usually is a function performed by a department of the sales division. In some organizations it may be a separate department co-ordinate with the selling organization, and both report to a common head who is a major executive.

Another organizational problem in selling is the question of centralization vs. decentralization. The two large mail order houses also have many retail outlets. Each is headed by separate managers and in many respects is run as a distinct organization. Again the question of home office control arises in organizations having national distribution. Where the branch managers have relatively little authority and have to receive approval from the central office for such items as credit, sales campaigns,

etc., they usually are lower paid, but the organization lacks flexibility and service suffers. Where the branch managers operate within certain broad policies, but otherwise as if they were independent concerns, the organization is more aggressive and flexible; this type of organization, however, requires a higher type of personnel and is more expensive. Usually the additional expense is justified unless the products are highly standardized. Frequently such items as advertising, accounting, and office procedures are controlled from the central office and the manager is given much latitude in the actual selling, and purely local matters.

The segregation of the sales force often is desirable where advantage is to be taken of the efficiencies arising from specialization. Segregation of the salesmen may grow out of the fundamental characteristics of the buyers of the same article or it may result from the differences in the nature of the products, or both. Taxicab fleet owners, automobile manufacturers, and the everyday passenger car owners buy automobile tires, yet the problems arising in selling each are distinctly different and can best be handled by specialists. The Nash-Kelvinator Corporation and the General Motors Corporation each manufactures both automobiles and electric refrigerators. The technical problems involved in selling these two products can best be cared for by specialists in each field. However, where customers are few and separated by great distances the advantages of specialized skills of different salesmen may have to be dispensed with in the interest of economy in traveling expense. Foreign trade usually presents so many special situations that they can best be cared for by a separate department or organization within an enterprise. In some instances a separate corporation may be organized to carry on the foreign trade for the parent corporation. The various situations arising in trade that may in one case call for segregation of salesmen are many. The controlling principle should be that the organization structure is a means to an end and not the end itself. The same business enterprise may wisely use a different structural organization of its sales force in different areas at the same time, or at different times in the same area.

Flexibility in either a producing or a selling department is highly desirable. The organization to be effective must constantly be evaluated in terms of its reasonably current expectations and demands. It should continue as a living entity co-ordinating the active interests of all concerned and not be the "hang-over" from conditions that have long since ceased to exist. Theoretically desirable sales organizations may well be created by the organization specialists. It is desirable for the salesmanager to have such programs before him as a goal to strive for. He must, however, as a matter of practical necessity, use the available personnel and, temporarily at least, adjust the organization to the capacities of this personnel. A planned training program will reduce

the number of special adjustments that have to be made to the desired organization.

Determination of sales price and terms of sale. Volumes have been written on each of the two factors, credit and price. We are interested, in this brief discussion, only in those phases that directly influence the organization of the enterprise in general and the sales organization in particular. Where the enterprise does a strictly cash business the necessity for a credit department is eliminated; likewise much of the record keeping is reduced. In some organizations the credit department answers directly to the treasurer while in other concerns the credit department may be a functional unit of the sales department. Selling on credit, even on open accounts, involves additional burdens of investigation, billing and follow-up of collections, as well as computations of discounts for cash or payment within a specified period such as ten days. Such a sales program ties up additional funds and thus influences the amount of money required for a given volume of business or the volume of business that can be carried on with a given amount of capital. Either approach directly influences the organizational structure of the enterprise.

Closely related to sales price is the factor of service rendered and the basis of payment for it. One manufacturer may give free service for a period of three months to a year. Naturally this service must be paid for in the original selling price. Another manufacturer may operate his service department as a convenience to his customers and a part of his advertising program, charging the customer actual cost, in some instances not including overhead and in other instances including all determinable costs. Still a third controlling philosophy is used by other manufacturers, namely, to charge for service not only the actual cost but an amount sufficiently high to give a profit. Again, there may be various combinations of the foregoing, such as the automobile dealer who gives free service for the first three months and then tries to make a profit on the operation of the service department as a whole.

In determining the sales price for a given article many factors may be considered by the sales department and the entire operating organization, such as: (1) monopoly or competitive position; (2) "charging what the traffic will bear" vs. price determination on the basis of cost of production; (3) desirability of large volume with low unit profit or high unit profit with relatively small volume; (4) elasticity of the demand for the product and the existence of substitutes, actual or potential; and (5) the short-run competitive price in the given market. In the absence of a monopoly situation competitive effort in the long run will usually tend to reduce the high unit profit. In an effort to maintain a semi-monopolistic position, intensive advertising may be engaged in.

While intensive national advertising by radio, magazines, newspapers, bill boards, etc., may not give a technically monopolistic advantage, it does in substance approach this condition, for only those organizations having tremendous capital available can successfully enter the field. This situation is well illustrated by the tooth paste manufacturers. Relatively few articles have an inelastic demand. Acceptable substitutes are available for most products when prices get out of line. In the short run, a manufacturer may be forced to sell his product at a price somewhat less than that necessary to recover all costs. This is true particularly during certain periods of the business cycle. Price determination is not solely a function of the sales department The board of directors in determining basic policies may elect to produce a high quality product to be sold to a restricted market on a relatively high unit profit basis. The ultimate long-run price is usually a compromise between external influences and the many interests of the internal organization.

Operating the Sales Department

The duties of the sales manager. Co-ordination of sales effort with the efforts of the manufacturing departments, with the engineering or design staff, and with the financial program of the business was seen in the chapters on budgeting to be a prime requisite for orderly administrative control of the major program of a manufacturing establishment. It is the development of the sales schedules of this master program and the administration of the developed schedules that we are considering now. The energies of the sales manager, in addition to his constant drive actually to sell what is being produced or will be produced, are partly taken up with thoughts of new lines of product to be developed. The design staff may be called upon by the general management to create some new product that can be produced at a given price, or that will meet some new demand of the market, but it is the sales manager who will have to pass on the practicability of the product from the selling standpoint, on the desire of the market for given products, or on the power of the market to absorb new products. In considering these conditions, the sales manager keeps constantly in mind the necessity of meeting changing consumer demand, and the creation of new demand which will be directed toward all or some of the product of his particular plant. The sales manager is aided in his search for new products or new uses for his present products by the technical research staff. In addition to providing the consuming public with what it wants and when it wants it, the sales manager is faced with constant pressure from the producing organization to aid in reducing seasonal variations. It should be emphasized that all these considerations will be of importance whether the

company manufactures primarily to schedule or primarily to customers' order. If the latter plan of operation be the one followed, the principal difference will be that the sales manager's task will be much more difficult, in that he will have to sell and plan for sales in terms of the extent to which current orders fill particular portions of manufacturing capacity. Delivery dates on new orders that are taken must then dovetail with promises that have been made on orders which have already been turned over to the production departments for manufacture. If the plan provides the manufacturing of standard products to schedule, the control of sales become somewhat simpler, although the energies of the sales force must frequently be directed toward the movement of certain articles which the market suddenly rejects after the budget and manufacturing program have been developed.

Sales promotion. Effective sales control can be secured only if there be carried on definite sales-promotion work, which will point the demands of the market in the direction which is desired. It must be remembered that the sales department occupies a dual relationship with respect to consumer demand. It seeks to discover what the public wants and to satisfy this demand. On the other hand, it is faced with the problem of acquainting the public with new products and in this case is creating new demands. This promotion work in large companies can, in its routine aspects, be handled in the main by a sales-promotion department, operating only under the general direction of whoever may be in major charge of distribution. However, the latter will be forced to lay out the major lines of operation for the sales-promotion department, if he is to correlate their work closely with that of his own direct assistants, and with the administrative program which has been laid down for the company as a whole. The sales-promotion department must be in constant touch with the salesmen or distributing agencies which are actually selling the product, and must be in a position to aid them to push a certain article in the manner which may seem most effective at any particular time. The control of advertising campaigns and appropriations may be placed under such a department, though the actual preparation of advertisements and direct contacts with publications or printers is often left in the hands of an advertising department, or with an advertising agency.

A sales-promotion department should know the customers and the trade thoroughly. In addition to this, it should be completely familiar with the products that are being manufactured. Through the head of sales, it knows the programs which have been laid down for a forthcoming period, and with all these factors in mind it constantly strives to promote the realization of the developed sales program. It gives the salesmen the home-office aid that is necessary, when and where it is necessary, and in doing this it co-operates directly with the salesmanager

or whoever may be in direct charge of the salesmen. It maintains a stock of the various "dealers' helps" which have been devised, and distributes them to dealers. This also will be handled in a way that will promote any particular campaign or program that has been determined upon.

Sales policies, such as guarantees, dealer-service, price-protection, and discounts, must all be developed so as to fit in with the promotion program and with the general administration program of the business. It will not avail to carry on whirlwind sales methods within the first portion of a business period in the effort to achieve some assigned quota, if this is but to result in reaction toward the end of the period that will entirely disrupt the plans of the executives.

Sales planning. The step which makes entirely practical the predetermination of sales effort and the resulting control is sales planning. If sales plans have been perfected, to carry them out will be but to call upon the technique of sales as developed in the sales organization through the ordinary channels of salesman-dealer or salesman-consumer relationship. Sales planning, certain aspects of which have previously been discussed, must be extensively developed before a sales program that will hold can be developed. Yet some of the most effective planning must be done after the formulation of the program and in an attempt to carry it out. In laying plans to carry out one sales program, lessons are learned which are of material assistance in formulating succeeding sales efforts. Planning for sales is predicated on the thought that the sales manager must act strictly on facts, must carefully determine these facts, and must supervise his force in a way that will bring measured results from these facts.

The details of the sales plan will be influenced by the decisions reached after due consideration of the factors discussed in the first division of this chapter under the heading of "Policies and Organization of the Merchandising Function"; namely, (1) analysis of the nature of the product; (2) analysis of the market to be reached; (3) choice of distribution channels; (4) the organization of the sales force; (5) price of article and credit terms; etc.

Not only must territories be allocated to salesmen but some means of checking whether or not this territory is being properly covered should be devised. Salesmen tend to follow the line of least resistance rather than the one of greatest long-run profit to the organization. Some sales managers have detailed route lists prepared for each salesman, indicating what towns are to be visited, and perhaps, whom he is to see in each town. Much valuable information can be secured from the salesman himself in this connection, but he should be called upon to present adequate reasons why certain towns or possible customers should be omitted from the list. Salesmen easily fall into the habit of neglecting outlets which

they do not happen to like. Some means must therefore be provided of checking calls against route lists which have been provided for them. Many firms provide an exact schedule for their salesmen, detailing exactly what calls shall be made by them on specific days, and asking for an adequate explanation of failure to make expected calls. One large house-to-house distributor of food products boasts that it can tell just where any one of its 1600 salesmen is at any time and not be in error greater than a distance that can be traveled in a half hour. Although it is frequently advisable to schedule the salesman's program much more in detail than was formerly the practice, nevertheless he should be allowed considerable freedom to adjust this schedule as occasion demands. Errors usually arise because of the schedules being controlled by a clerk who is not familiar with operating conditions in the field. While a clerk may do the paper work even better than a salesmanager or one of his major assistants, where questions of judgment arise, the decisions should not be left to a clerk. When these precautions are taken, scheduling of salesmen usually increases the efficiency of sales effort.

Setting sales quotas. To fix quotas, it is essential that territories shall have been first clearly defined, in order that they may be studied, and the fair share of projected sales apportioned. Not only for this reason, but in order to make equable the opportunities and compensation of the salesmen, territories must be clearly defined and studied. The quota itself, like any other task, should be fixed in such a manner as to be readily attainable. There is no object in setting quotas at a point which is known to be utterly out of reach. Thus the quota should be set after careful study of the current situation, not on previous sales, or any arbitrary increase over previous sales. Such a practice as an arbitrary increase merely penalizes the salesman who has always done well consistently and throws out of balance the plans for total sales that are being laid. Although quotas must be fairly well worked out before the sales estimates are submitted for budget-making purposes, nevertheless they will have to be revised after the adoption of the budget to insure that its schedules are attained.

Quotas must be set with certain factors within the territory in mind. The first is the accessible population. Inaccessible population cannot be counted. Some knowledge of trade customs within the territory is involved here. On goods which are sold for household purposes such factors as the strength of mail order houses must be taken into account, and the character of transportation facilities must be considered. On products which are used largely in trades or in manufacture, the usual channels of purchase must be thoroughly studied. The only population of value is that which may properly be expected to be in the market for

the product. Thus, if quotas are being set on shirts retailing at $3.50, the available population is reduced considerably under that which must be considered in setting quotas on shirts which sell for $1.50. Crude population statistics are, therefore, of little value in setting quotas, although they may be utilized as a point from which to start. The number of outlets must be determined. This may be the number of dealers, or in some cases the number of direct users of a product. Thus the quota of a branch sales office of an automobile accessory manufacturer located in Detroit would necessarily be higher than the quota of the Cleveland branch. The volume of prior sales must be given some consideration, as must the extent of competition within the particular territory. This last factor may run up cost of sales to the point where it may be desirable to abandon certain territories such as the sparsely populated areas in Nevada. The relative advertising expenditures compared with those of competitors must be taken into account. Market conditions within a territory should affect the quota set for it. Thus, crop failures in a farming community must affect the quota set for that community the next year for nearly all products. New sales efforts may affect all quotas, or they may affect some to a greater extent than others. If intensive advertising campaigns are to be run in certain sections, the quotas for those sections must be advanced correspondingly, as the salesman and dealer aid from this source will be considerable.

Maintaining the sales force. As in all other phases of business the maintenance of an adequate working force is a major responsibility of the directing head of the division. He may delegate this responsibility to a functional unit serving at times other divisions of the enterprise, but it is still his responsibility to see that it is done. Salesmanagers are frequently hesitant to make complete use of the employment department, preferring to hire their own men. This attitude may be justified where the employment office is developed primarily to serve the factory producing unit. In modern employment offices, however, there are well-trained men who are specialists in hiring office and sales workers just as there are others who devote their time to employing mechanics. The qualifications desired in a salesman are determined largely by the particular sales task to be performed. Some products require technically trained men to sell them successfully. Certain types of experience have been found in other cases to provide a desirable background for special products. The man who has made a success in selling taps, dies, and abrasives has been found by hacksaw and file manufacturers to be a likely prospect for making a good salesman of their products. Insurance companies have found certain experience, educational background, and age qualifications to be desirable. The factory and service departments frequently provide excellent men for the sales group. Such employees

are already known to the management, are familiar with company policies, and require a shorter training period. The training program is usually adjusted to the needs of the particular enterprise. The understudy system, after an intensive training period in the factory, is used extensively for traveling salesmen. In department stores the sponsor system is frequently used Some organizations have regular sales courses through which they put all new salesmen. Another phase of the training program is the "in-service training." This program is particularly difficult in the case of salesmen operating far from the home office. Under such conditions there are two basic problems. One is to keep the salesman informed regarding the improvements in his product, and the other is to keep him sold on the policies of his company. Correspondence courses especially designed to acquaint the salesman with his products, special sales helps pointing out technical developments and new sales methods, and regional or home office conferences are the common methods of training field salesmen. Where the sales people are under one roof or within a given area the sales conference is most successful even though sales helps may be used.

Salesmen must be selected for particular territories with a view to the buyer resistance or acceptance within that territory. Polished salesmen might succeed in one place where rough-and-ready salesmen would succeed in others. Although a really successful salesman seems to adapt himself to whatever conditions he meets, buyer resistance is cut down by properly apportioning territories among the sales force. The enthusiasm of salesmen in attaining sales goals can be stimulated by methods of payment, as indicated in Chapter XXXV. If salary payment and commission payment are adopted, the two methods must be balanced so as to be most effective. However, this must be so arranged that the entire urge will not be in the direction of increasing the amount of sales, with possible injury to net profits from sales or to customers' service. Commissions should also be based partially on the success of the salesman in reaching quotas which have been established for him. That is, compensation must be based on production, and production in turn must be determined in relation to a set task and quota. This task or quota may vary with the product, with the territory, or with the salesman involved.

Analysis of Sales. Sales planning must be followed by a careful analysis of results achieved, if plans are to be modified and corrected as necessary. Territories which have proved to be unprofitable must be given up. Territories which cannot be adequately covered by one man or which might be better handled by another branch, should be changed to fit ascertained conditions. Careful study of campaigns which have been previously planned will give satisfactory information for these

changes that affect subsequent campaigns. As plans become more effective, high-priced salesmen should be utilized more and more on high-priced work, and satisfactorily directed from a home office through the utilization of low-priced clerks to aid the sales manager.

The director of distribution and the sales manager, if these be different persons, are enabled, after they have established the control which has been outlined, to co-operate more intelligently with the production executives, truly to determine their best salesmen and best branches, and to reward them accordingly. Furthermore, the sales manager is enabled to travel into difficult or highly competitive territory and to lend a helping hand to his salesmen there. He can be confident that the remainder of the men will be working toward a definite goal while he is thus helping a single individual, and he will gain much-needed knowledge of actual competitive conditions by being free to swing from under the routine of office work and work with his salesmen. Special awards, bonuses, and contests for salesmen come to have real significance if sales have been previously planned. The sales manager will find that, through these aids, he will have the concerted effort of the whole sales force bent towards the fulfillment of the sales promises which have been made to the general management and the other operating departments. Without planning and subsequent analysis, he will be playing a lone hand trying to make good on his promises, and through main strength, endeavoring to bring the members of the sales department to his assistance.

CHAPTER XL

CONTROL OF PURCHASES

Functions of the purchasing department. Regardless of the position of the purchasing department in an industry, it performs a *primary function,* which, when efficiently carried out, materially contributes to the profits of an enterprise. Purchasing's direct economic contribution is *place utility;* however, it is closely related to *time utility,* since the materials must be on hand when needed. The major objectives of the purchasing department may be summarized as follows:

1. To provide the necessary materials, supplies, and services of the quality and character required.
2. To provide these materials, supplies, and services for the enterprise so that they will be available when wanted.
3. To secure these items at the lowest possible cost consistent with sound business practice and ethical procedure.

To carry out these major objectives, the purchasing department is required to perform the more detailed functions as follows:

1. To interview salesmen regardless of whether or not an immediate purchase is contemplated, thus maintaining one of the important public contacts.
2. To formulate specifications or at least to co-operate in their final determination.
3. To secure quotations on the major purchases, compare these quotations, and place the order in keeping with the policies of the organization.
4. To purchase direct all smaller items not requiring a quotation or bid.
5. To formulate interdepartmental policies and to participate in the formulation of company policies that pertain to purchasing and public relations that influence purchasing.
6. To inspect (or to see that inspection is carried out in case it is performed by another department) all purchases for quality and count.
7. To follow up all purchases to see that delivery is made when promised.
8. To approve all invoices for payment.
9. To be on the alert for new developments either in processes or in

materials and to call these to the attention of the major executives charged with the specific responsibilities that are involved

10. To maintain adequate records of sources of supply and the character and reliability of each source of supply.

11. To study economic trends in the market for specific commodities as well as business in general.

These functions are to be performed by any well-organized purchasing department and are by no means arranged in the order of importance nor are they exhaustive. For example, the keeping of inventories at a minimum consistent with production requirements is a function of the purchasing department in many institutions, although this responsibility frequently is placed upon the stores department, the production control department, or some other department. Naturally the purchasing department is charged with the responsibility of staying within its budget when operating under an allotted budget.

Position of purchasing department in the organization. It sometimes happens that the purchasing end of a business is directly subsidiary to the selling end, or at least they go hand in hand. Such a case always exists in a manufacturing concern where there is a quick turnover of all raw material that is purchased, with only a slight additional process having been performed. This frequently occurs in markets which are highly organized, such as the cotton or flour markets In these cases and others, where "hedging" is carried on to protect from loss, it is practically essential that the sales and purchasing ends of the business be under the same direct control. Of course this does not apply to the purchasing of supplies. An example of such a condition is to be found in the business of mercerizing cotton yarns, where the yarns are frequently bought and sold within a few minutes' time, and the mercerizing operation, which is all that is performed by the plant, adds but little to the value of the product.

There are many other types of businesses in which the manufacturing operations are more involved and relatively more important, but in which the position of the purchasing department must be one of maximum importance. Such businesses include most of the needle trades which purchase expensive fabrics, such as men's clothing. In such an industry, a very large share of the profit made during the course of the year is made from purchases at the right time or of exactly the right materials. Thus the cost of the material purchased is an important consideration in the authority granted the department.

The importance of the purchasing department in factories manufacturing complicated products may depend on the degree of standardization. If the product be standard, the scope of the purchasing agent's

authority usually has been so limited by those who drew up the specifications that his task is fairly simple, and, therefore, one that is subject to general manufacturing control. If the product be not standard, the purchasing agent usually must decide many matters concerning the purchase of material which would not come within his jurisdiction with a standard product. Hence, his position within the organization will be correspondingly increased in authority and importance.

Curiously, there sometimes develop, for very different reasons, violent objections on the part of general executives to clothing the purchasing agent with much authority. There are three such reasons which are worthy of mention. In the first place, there is the major executive who feels that there is "nothing to purchasing." He feels that his trouble has always been to sell his product, that other men are just as anxious to sell their products as he is to sell his, and that, therefore, the task of purchasing is comparatively simple. As selling has come to be more and more a scientifically studied vocation, the purchasing department has in self-defense provided the answer to this idea by employing means as scientific as those employed by the salesman.

Many major executives enjoy doing all the important buying themselves. They find lots of fun in spending their own money, and they do not want a purchasing agent to do it for them. It gratifies a certain egoistic impulse to spend the company's money even though it does not belong to them. Most executives would vigorously disclaim any such motive, but it seems to be the best explanation of their actions. Besides, purchasing brings them into contact with other men in their industry in a way that almost no other phase of the business can do. These contacts, particularly if they have lasted over a period of years, frequently make of the purchasing agent a mere routine order-placer. There is usually a type of purchasing which, in any case, must be reserved for approval by the higher officials. An illustration is the purchase of expensive equipment, such as machinery.

In assembly manufacturing, the third general cause for limiting the power of the purchasing agent is a very vital one. Decisions must be continually made whether to buy or make a certain part. The answer in any given case is likely to be influenced by the state of the market at the time, the manufacturing conditions in the shop, both in regard to the need for the product and the possibility of putting it through production, and in regard to the desire to build up outside sources of supply to fill future needs. General executives sometimes feel that they are the only ones who can pass on such questions. However, if the purchasing agent be competent, and if there be provided a committee organization with a main factory committee, such matters form an excellent subject for decision there. The purchasing agent can be advised,

under such circumstances, by the factory and design representatives who may be present.

In the main, in a modern organization, the purchasing agent works toward the quality specified by the engineering or design department, and the quantity specified by the production or planning organization. It has already been shown that most purchases will originate through the inventory control that is maintained at the balance of stores desk, and that this control will usually be exercised from the planning department.

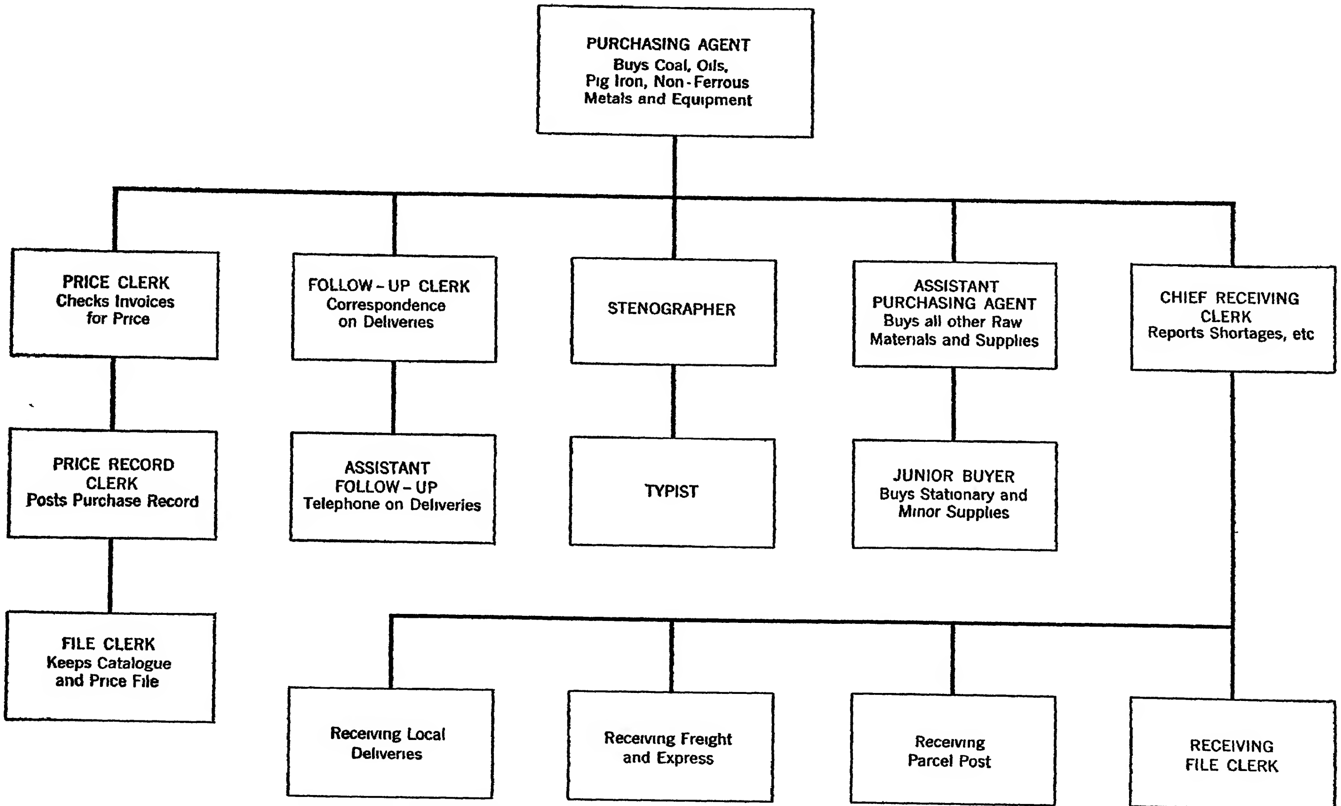
Regardless of the position of the purchasing department in the factory, there should always be some means provided for keeping the head of that department closely in touch with all conditions that may influence the course of his daily task, at least in the immediate future. Breakdowns in the operation of many purchasing departments can be traced to the fact that, owing to sudden changes of policy, which had been developing but of which they had not been apprised, conditions of requisition so changed over night as to make it literally impossible for the purchasing department to function properly.

Organization of the purchasing department. The purchasing function in well-managed enterprises is usually performed by a separate department; however, it must be admitted that even in some well-run organizations all items are not as yet bought through the purchasing department. In this phase of organization, as in many others, the relative strength of individuals frequently influences the organizational structure. All too often a strong master mechanic buys not only his machinery but the supplies as well. There is good reason for him to specify certain qualities desired or even specific products, but there is little justification for his spending valuable time purchasing materials the specifications of which have already been determined. This does not mean that he should never see salesmen with new products with which he is not familiar. Sound purchasing practice would bring the master mechanic into the picture in all decisions involving technical matters concerning which he is specially qualified. To have purchasing carried on by every man who has a special interest violates the fundamental principle of functionalization. Relatively few department heads can take the time to analyze the market to determine the going price, the reliability of the firms, and any unusual conditions that may prevail at the time. Purchasing by department heads usually results in a higher price than is necessary and frequently is conducive to placing of orders more on the basis of personal likes and dislikes than on the merits of competing products. Such practices may readily lead to direct or indirect bribery. Centralizing purchasing in the purchasing department will not eliminate the temptation to accept bribes, but it removes the number of places to

guard. Buying through a well-organized purchasing department tends to avoid either having too much material on hand or running out of needed material. The purchasing department specializes in this function and has time to devote to it. Purchasing involves much clerical detail that is usually distasteful to most department heads, who tend to neglect it when they do the purchasing. The result is that the company pays for this neglect when it permits the department heads to do their own buying.

The internal organization of the purchasing department is greatly influenced by the size of the enterprise and the nature of the items bought. At the head of the purchasing department is usually a purchasing agent. He may answer to the president, or a purchasing committee in the larger organizations. His title may be that of vice president in charge of purchasing, director of purchases, purchasing agent, etc. In medium-sized organizations the purchasing officer may occupy the same high position that he holds in the larger organizations; however, he more frequently reports to the general manager. As organizations decrease in size the purchasing department tends to be placed in relatively less important positions. It is not infrequent in the smaller organizations to combine purchasing and storeskeeping. In the smaller organizations there will usually be only one buyer who may divide his time with some other duty. As the duties expand and the size of organizations increase, the number of people in the purchasing department increases. In the larger purchasing departments a high degree of functionalization takes place. Such organizations usually have a purchasing agent, assistant purchasing agent, buyers, file and record clerks, stenographers and typists, traffic division, follow-up division, materials engineer, depending upon the size and magnitude of the work performed. Where the volume justifies the specialization one buyer will buy certain materials and another buyer will buy something else. There may be separate buyers for coal, lumber, steel, small tools and supplies, rubber, chemicals, etc. The purchasing department is a functional department itself but usually is organized on a line and staff basis within the department. Figure 137 illustrates a typical purchasing department in a large industrial organization.

Centralized vs. decentralized purchasing. In large companies having plants in different locations the question of central buying vs. local buying must be settled. This same situation within a given plant was discussed above under Organization of the Purchasing Department. The phrase popularized by the General Motors Corporation, "decentralized responsibility with co-ordinated control" sheds some light upon their philosophy in solving this phase of their organization. It is their policy to buy centrally those major items which can best be purchased by the



(Adapted by permission from L P Alford's "Cost and Production Handbook," p 335, Ronald Press Company)

FIG 137. Detailed Organization Chart for Purchasing Department.

central organization. When these items are not purchased by the parent organization they usually are bought by the main purchasing unit of the divisions. Many of the divisions have two or more plants. The less important items frequently are purchased by the local plant when this is advantageous The same situation is found in the big rubber companies. For instance, it would be absurd for each of the plants of the United States Rubber Company to buy its crude rubber independently. The same holds with respect to compounding ingredients and fabric. To buy independently would most certainly involve inventories in excess of need, and the prices paid by each unit would tend to be greater than the price paid by the central purchasing department. A higher degree of specialization in purchasing is possible when purchasing centrally than when many different buyers are buying the same item in many locations. Central purchasing also facilitates the transfer of excess stocks of a material from one plant to another. Better financial control is exercised when the major items are purchased centrally. Coordination may be maintained by having the central purchasing department prescribe the general routine and procedures but permit the local unit to exercise discretion in purely local matters. Where necessary or advantageous, all bills may be sent to the central purchasing department, where they are checked and approved for payment by a central agency. This practice frequently involves extra clerical work and expense. No fixed rule is applicable for satisfactory purchasing for all organizations. Purchasing, like other functions of a business enterprise, must remain flexible in order to meet changing conditions.

Authority of the purchasing department. Closely related to the organization of the purchasing department is the authority vested in the department. In fact, this authority usually grows out of the place of the purchasing department in the organization; or reciprocally, the authority of the purchasing department influences the position in the organization assigned to it. The authority of the purchasing department with respect to finances must be limited in all cases. It must be operated on some sort of a budget system, whether or not this system has been adopted for the company as a whole. To require that all purchases be approved by the financial management of the concern too seriously limits the operation of the purchasing department, but to allow it to purchase regardless of the condition of the finances is manifestly impossible. The most effective means of controlling the financial end of purchasing work is through the operation of a general budget scheme, such as has been described. However, if there be no general budget, very effective purchasing budgets may be set up which will prevent inventories from mounting through improper purchasing operations, or through mistakes in running balance-of-stores sheets.

Sometimes, in the case of standard product, the purchasing department is allowed to purchase on the basis of the normal consumption for a given period, for instance, three months. They can purchase up to this point, and then further purchases can be made only on an allotment of additional funds from the financial end of the business. In unstandardized lines, the purchasing department is given a budget of so many dollars per month, and they can buy any and every type of material up to the total of moneys so allotted them. After they have reached this point they must seek further authorization before buying more. Either of these budget methods forces the purchasing agent to keep very close watch on his finances to see that he may be able to purchase toward the end of his budget period.

Policies of the purchasing department. The determination of policies is the function of the major executives. The controlling of policies for purchasing is no exception to this general rule. An active purchasing agent should participate in the formulation of purchasing policies and may initiate many of them. Such decisions as to operate on a purchasing budget, to buy or to manufacture a given article, speculative purchasing, hand-to-mouth buying, the substitution of one material for another, etc., involve other departments and cannot safely be made except through the co-operative effort of the major executives concerned. Certain other policies, such as whether to ask for competitive bids, to place the order with the lowest bidder, to divide a large order even though one supplier may be able to fill it, etc., are borderline decisions and may or may not be left to the discretion of the purchasing department. A properly organized department may well make these decisions. The internal organization of the purchasing department in keeping with the organization structure of the enterprise as a whole may well be left to the department head.

Reciprocal purchasing is one of the most annoying practices encountered by an efficient purchasing agent. Reciprocal buying refers to the practice of buying a given product because the vendor also buys the product made by the firm that in this instance is seeking to buy. It is the old political game of "You scratch my back and I'll scratch yours." The practice is as obnoxious to the purchasing agent as the phrase used to describe it. The fact remains that it exists. During periods of prosperity reciprocal buying recedes into the background. When sales are hard to make pressure is frequently exerted to get the purchasing agent "to remember that we are one of your best customers." It is surprising the lengths to which some sales organizations will go to make a sale when sales are slow. There is no criticism against the purchase of a product from a customer when his price is right and his product is the one desired. In this case the purchase would be made

even though the vendor were not a customer. This is straight purchasing on merit and is not classified as reciprocal purchasing.

Hand-to-mouth buying. Hand-to-mouth buying is the phrase used to describe the practice of buying small quantities as needed in contrast to buying in larger quantities for stock. Hand-to-mouth buying came into favor following the depression of 1920. In reality it is a method of guarding against being caught with large inventories on a declining market. It is sound economics when not carried to the extreme. The practice has both social and economic advantages and disadvantages. Some of the *advantages* claimed by the advocates of hand-to-mouth buying are as follows:

1. Hand-to-mouth buying reduces the inventory of materials on hand and releases the capital that would be tied up for other productive purposes.
2. Storage facilities, storage costs, and handling costs are reduced when deliveries are timed so that the material may go direct to production. (One automobile purchasing agent boasted that his materials came in the receiving door and did not stop until they came off the assembly line as a part of the finished car.)
3. The budgetary requirements of production are more easily synchronized with purchasing.
4. The buyer and the seller have more frequent contacts and thus are enabled to work more closely together to the mutual advantage of both.
5. Losses arising from a decline in price are minimized by the buyer. (On the other hand, he may pay a higher price for his annual consumption during a period of rising prices.)
6. The buyer is in a position to take advantage of any favorable situation arising in the current market.
7. The buying organization is in a more flexible situation in that it may make changes in the design and nature of its product or adopt new or substitute materials more readily.
8. It should tend to level out production since the producers have a better check on requirements than when the consumers buy in quantities and store a large part of their requirements. (This claim is true only in part, depending somewhat on the product. Since the practice has been adopted by the householder in the case of coal, it has tended to increase the seasonal fluctuation because the producer cannot store his coal in the summer, nor can the coal yards absorb all the storage.)

The disadvantages of hand-to-mouth buying are many, a few of which are as follows:

1. The producers are required to keep larger inventories than formerly since the buyers rely upon the producers to carry the reserve inventories

for them. (The grand total social or economic inventories are less but the producer's inventories are greater.)

2. Unit purchasing costs on the hand-to-mouth basis are higher because of the failure to take advantage of quantity discounts.

3. Distribution costs are higher because of: (*a*) a larger number of sales to accomplish the same results—the actual cost of making a large sale is very little if any greater than a small one; and (*b*) increased packaging cost, order-filling cost, and transportation costs when in less-than-carload lots.

4. In some instances seasonal peaks and valleys are increased.

5. The buying public, the individual consuming citizens, do not usually get as good service when the manufacturer of the original articles carries the inventories. This is true especially when the retailers also buy on a hand-to-mouth basis. Often the manufacturer cannot take care of sudden increases in demand, for his inventories are not large enough to absorb this increase. Where buying for stock is more general the grand total inventory in existence is greater and consumer demand can be met more readily.

A compromise between hand-to-mouth buying and buying for stock seems to be more desirable than either practice to the exclusion of the other. Maximum and minimum stock ordering points may be increased during periods of rising demand and contracted during periods of relatively slow or decreasing demand. This does not imply speculative buying. When a budget is being used a three-months anticipated requirement may reasonably be determined. The full amount may not be purchased at once but purchases will certainly not approach the hand-to-mouth basis. Larger orders may be placed with provisions for price adjustment in case of a decline and shipping instructions to be issued as required. Such a procedure has advantages for both buyer and seller in the long run.

Methods of buying. Alford lists seven different methods of purchasing as follows:

1. Purchasing strictly by requirement.
2. Purchasing for specified future period.
3. Market purchasing.
4. Speculative purchasing.
5. Contract purchasing.
6. Group purchasing of small items.
7. Scheduled purchasing.[1]

[1] L. P. Alford, *Cost and Production Handbook*, The Ronald Press Company, New York, 1937, p. 360.

To purchase by requirement is to purchase only when needed and in quantities needed. Such goods as are purchased by requirement are usually those goods that are not purchased regularly but are bought to meet a specific emergency need. The outstanding function of the purchasing department in this type of buying is to know the sources of reliable firms.

Supplies are often bought for specified future periods. These items are standardized products that are bought regularly but in relatively small quantities. The period covered by such purchasing is not a fixed one even for the same general class of material. Operating conditions, quantities required, and the same general factors that influence other types of purchasing are controlling.

Market purchasing seeks to take advantage of price fluctuations. It involves careful study of general market trends and the purchase of materials that are required in the light of reasonable market expectations. Utilities and manufacturing enterprises that can predict their requirements with reasonable certainty may safely engage in market purchasing and still not be directly involved in speculative purchasing. Raw materials such as rubber, coal, coke, and pig iron are frequently purchased on this basis. Market purchasing is definitely tied in with planned production schedules whereas speculative purchasing gives less attention to production requirements and is based largely upon expected changes in the market price. Speculative purchasing is engaged in extensively by manufacturers of cotton cloth or users of cotton cloth. It is not unusual to have the major profit arise from speculative buying. The corollary to this, of course, is the fact that production operations may be efficient yet losses are sustained by errors in judgment in the speculative purchases. A major executive usually directs speculative buying. In reality speculative buying is a business within itself and may saddle production with costs that the producing group have no method of getting out from under. Such items as obsolescence, demand for excess storage space and handling, uncertainty as to available material when needed, are problems that the manufacturing group must contend with when speculative buying is indulged in.

Contract purchasing as the name implies, is the purchasing under contract, usually a formal one, for needed materials, the delivery of which is frequently spread over a period of time. Under the NRA codes coal was frequently purchased on this basis with a variable price per ton inserted depending upon the wage paid the miners. Such provisions are not usually included because they defeat one of the major advantages from the buyer's standpoint, namely, to take advantage of low market prices to contract for requirements for a specified period.

Group purchasing seeks to take advantage of the savings that would naturally accrue through the placing of one order for a number of small items rather than placing a large number of small orders. Group purchasing reduces the cost to the buyer by eliminating much clerical work and also saves the vendor a great deal of clerical detail and delivery costs. The balance-of-stores clerk or other person placing requisitions with the purchasing department can be of real service in grouping these requisitions. The purchasing department should re-examine group purchases from time to time to make certain that given items should be included. A failure to do this is one of the real dangers in group purchasing.

Schedule purchasing is closely related to carefully controlled production. It extends to the vendors some of the advantages of production control within the plant and thus enables them to plan their production and control their quality more effectively. Scheduled purchasing tends to reduce the inventories carried by the buyer, and permits the vendor to control his inventories more closely since he is not placed in the position of having to meet unexpected demands. Scheduled buying requires good faith and active co-operation on the part of both buyer and seller. On the other hand, scheduled purchasing tends to promote this good faith.

Drawing up specifications. One of the most difficult phases of purchasing department work is to draw up adequate specifications. The design or engineering department's requirements must govern, and yet the specifications must be in accordance with trade practice and trade terms. Specifications are most essential, if product is to be standard and if bids are to be asked for and compared. Much of the secret of good purchasing lies in drawing good specifications which vendors must live up to. This is a real money-saver, because it prevents a concern from paying for a brand or trademark name, which has been built up at high advertising cost, when the same article can be purchased elsewhere at less cost. In addition, purchases may be made on a level of quality which is just good enough and not too good for the purpose at hand. Purchasing on specification is not particularly popular with vendors who have in their regular selling price the cost of establishing their trademark, but all companies, no matter how small, can use it. Its only requirements are care in setting the specification and in inspecting goods upon arrival.

At times specifications may well be modified to suit the needs of the vendor. Thus slight and unimportant modifications of specifications may bring considerable reductions in quoted prices because the revised specifications will fall within the standard output of one or more of the vendors. Sometimes specifications are not determined by the

buyer or by the vendor, but by the market. This is particularly true with those commodities which are subject to wide quotation, such as raw cotton, staple cotton yarns and cloth, or lumber. In such cases, the purchasing department can only determine the grade to be bought, and then see that the commodity as delivered comes within the market regulations for the grade ordered.

In some organizations the engineering department determines specifications. Even in this type of organization the purchasing department has an interest in the specifications and frequently makes suggestions that result in large savings in purchasing. It is apparent that under such circumstances the purchasing agent must have a good technical background.

Knowing the sources of supply. The purchasing agent who makes most profit for his concern will generally be the one who is in touch with the greatest number of sources of supply, and who will get these most frequently into the bidding, either actively or indirectly. He will know the vendors who are in the best position to furnish given articles most cheaply, and he will constantly have in mind the various freight rates and discounts which will affect prices of the goods laid down at the factory door. Inviting competition is the surest way of securing the best possible prices. It is not the thought that bids should be secured every time there is an order for $10 to be let. This is perhaps the surest way of arousing the wrath of vendors, and only large plants can successfully purchase on the basis of competitive bids under any conditions. However, the door of the purchasing agent's office should be open to any salesman who desires to see him. To give the idea that the door is open only to a few favored ones is to stifle competition and ultimately bring high prices. Salesmen are trained in their product and have ideas which are valuable to the purchasing agent and to the concern which he represents. To win the favor of as many vendors' representatives as possible is to have these men also working for the interests of the plant.

The purchasing agent of a large plant in the automotive field once cost his firm thousands of dollars because of his refusal to see a representative of a steel concern making a new, lighter steel which would have materially reduced the cost of a number of the parts of the product. Because he was in the habit of dealing through accustomed sources, he refused this salesman the opportunity of demonstrating the practicability of his product, and it was not until the latter could work through other friendly channels, some months later, that the engineering department heard of the newer steel and changed its specifications to permit its use. The purchasing agent should be in constant touch with the newer developments of the trade, in just this way. He can be of invaluable aid to his company, and particularly the engineering or

design department, not only through the judicious placing of orders, but through his knowledge of trade conditions.

Purchasing Procedures

Initiating the request for material. The department or individual that takes the original step to start the purchasing procedure will depend somewhat upon the organizational structure. Regular materials used in production are usually under the control, for record purposes, of a balance-in-stores ledger clerk. The functions of this individual are strictly clerical and not policy-determining. He operates within certain carefully prescribed limits When minimum ordering points are determined and maximum ordering quantities are fixed, this clerk fills out a requisition when the ordering point is reached. This requisition may be sent to the superintendent, general manager, production-control department, or direct to the purchasing department, depending upon the procedure previously determined and the department supervising the balance-in-stores ledger clerk. For maintenance supplies the order may originate with the maintenance department in cases where these materials are not under the balance-in-stores clerk's control. For engineering or technical materials, the order usually originates in the engineering department. Where central purchasing is practiced, these orders are sent to the purchasing department regardless of the person taking the initiative in starting the order. It is not at all unusual for the purchasing department to have to go back to the department requesting the material for additional information even though the order may have originally been filled out by a technical expert. A common occurrence of this type is for the maintenance department to fail to give the serial number of a machine for which it is ordering some replacement parts.

Securing quotations or bids. For certain standard items purchased in large quantities or other items purchased according to specifications it is often advantageous to secure quotations. The securing of these quotations is primarily a function of the purchasing department. The purchasing department sends to a selected list of suppliers a request for a quotation for the specific articles or materials giving the detailed information or specifications, the quantities desired, the delivery schedule expected and practically all the information found on the regular purchase order. A special form that cannot easily be misinterpreted for an order is usually used when requesting quotations. When the quotations are received and prices compared, the order is usually let to the lowest bidder who can meet the requirements laid down. When the purchasing department is functioning properly this usually will be to the lowest bidder since they will not request a bid from an unreliable supplier.

A matter of business ethics is involved in the handling of quotations. Under no circumstances should a competing vendor be permitted to see the quotation of another and then revise his quotation to underbid him. A buyer who follows such practices is sooner or later found out and pays a heavy price for such practices.

Placing of the order. When purchases are made on a competitive bid basis the purchase requisition is sent to the successful bidder. When a purchase is made without competitive bidding or formal quotations, the purchasing department gives the order to the firm it wishes to patronize. It is an unnecessary waste of time and money to ask for formal quotations on small items. Prices in such cases are usually determined over the phone, from salesmen calling at the purchasing department, or from price lists sent out by the suppliers. Whether the item be large or small, it should be purchased by using a purchase requisition. This may be for record purposes if nothing else. Such items as a single bolt may be purchased out of petty cash, but these are relatively infrequent purchases in an industrial enterprise. The purchase order is usually made out with two or more copies, the exact number depending upon the needs of the organization. Some of the uses for various copies are as follows:

1. Original or vendor's copy is sent to the vendor.
2. Copy is kept in the purchasing department and filed numerically by the order number for ready reference.
3. Copy is sent to the receiving department as a notification to be on the lookout for the material.
4. Copy is sent to the department initiating the order.
5. Copy is sent to the accounting department.
6. A copy is sent to the follow-up clerk or division of the purchasing department.
7. A copy is sent to the inspection department.

Few organizations use all seven copies but nearly all of them, save the very small ones, use at least two or more, frequently three.

The purchase order is a very important document and should be so drawn that misunderstandings are not likely to arise. It should include the following details in addition to the firm's name, and the date.

1. Purchase order number to be used by the vendor in billing and shipping the material.
2. Quantity of material ordered expressed in terms commonly used for this purpose.
3. Description of the material ordered in detail so that there can be no chance of error. This description should be in terms of standard specifications where possible.

4. Delivery date requested.
5. Detailed shipping instructions, the place to be shipped to, the method of shipment when this is desired, packaging, etc. Where these items are omitted the vendor will follow his own interests which may not be in keeping with the desires of the purchaser.
6. Billing instructions.
7. Price, when an agreed price has been established.
8. Terms, when these have been agreed upon.
9. Any other item of importance such as protection against damages arising from patent infringements, etc.

In letting orders, it is essential that the purchasing agent shall know general market levels of prices, as well as the prices which he is being asked for particular materials This will enable him better to appraise the quotations which he receives. He must also have a thorough knowledge of discounts and datings current in the trade at the time. Frequently, although reductions from list prices cannot be secured, the same effect may be gained by an increase in the discount for cash. Particularly in times of tight money, purchasing agents who are alert can reduce the cost of purchases materially by this means. In order to know when to let orders, the purchasing agent must have a background knowledge of general business conditions If he is not to be afraid of quickly rising or quickly falling markets, he must study trade reports and general reports of business conditions; these are readily available.

In letting orders, the purchasing agent who gives the vendor the most consideration on delivery dates will secure the most favors in the long run. Some purchasing departments have built up reputations for always putting the word "Rush" on orders. This is either disregarded by the vendor, or it puts the buyer at a complete disadvantage on price. If prices quoted are not affected on that order, they are very likely to be so affected on the next one. If the stores records are properly maintained, there will usually be no reason for asking vendors to rush most of their orders, and proper delivery dates can readily be set.

Some general managers keep careful watch over the relations of purchasing agents and vendors, with the idea that the purchasing agent is representing the company before a large portion of the business world, and that the impression which the trade will get of the company and its policies will be determined largely by the actions of the purchasing agent. With this in mind, restrictions on methods of letting contracts are often put on the purchasing department by the general management. For instance, requirements as to the securing of competitive bids on large contracts are often imposed on the purchasing department quite as much on account of the impression which this makes on the remainder

of the trade as to secure lower prices. Some companies will not allow the purchasing department to let contracts to another than the lowest bidder, without consulting some designated member of the general management.

Follow-up, receiving, and inspection. To follow up purchase orders is a specific function of the purchasing department. In the larger purchasing departments this function is frequently performed by one or more persons devoting most of their time to it. It is not unusual for a representative of the purchasing department to work closely with the traffic department. The exact nature of the follow-up depends largely upon circumstances. Often a telephone call is sufficient. Again, the situation may require a more detailed report by letter or an inspection trip through the supplier's plant. When traffic jams occur at central rail distributing yards such as Toledo, Ohio, and Russel, Kentucky, the follow-up man may have to go out in the yards, locate the car having his material in it and bring pressure to bear upon the yard master to move the car. In other words, a good follow-up man must be versatile and must be prepared to do any reasonable thing to get his purchases delivered on time to meet production needs.

Receiving may or may not be under the direct control of the purchasing department. However, a close relationship exists between the receiving department and the purchasing department regardless of lines of authority. It is essential that the receiving department notify the purchasing department of the receipt of all purchases, as well as the count and the condition of the material when received. Where there is a separate inspection section for the receiving department, this division reports on the quality of the goods received and at times on the count. Either the receiving or the inspection department must notify the purchasing department regarding the count and condition of material received so that the purchasing department can approve the invoice for payment. The copy of the purchase order sent the receiving department may be returned to the purchasing department with the correct count and condition of material noted on it, or this same information may be given the purchasing department on a special inspection or receiving report.

Standing behind the purchasing decision. One of the most effective means of securing the long-run good will and interest of vendors is by standing behind the purchasing decision and not cancelling in times of changing price conditions. The cancellation evil has come to be of great importance in some trades, and those firms which have a reputation of always taking what they order occupy a position which gives them the cream of materials and prices. Only a superhuman man can beat the market both up and down all the time, and it is usually better

to win the good will of important vendors than to cancel for the saving of a few dollars, providing cancellation be permitted. There are a number of ways in which vendors and salesmen can favor purchasers, such as in tips of forthcoming price adjustments and bargains in odd lots of usable materials. The company which does not cancel is likely to be the one that secures these favors. Furthermore, if frequent cancellation is the reputation of a company, it is likely to suffer from slow delivery, because the vendors will wait to assure themselves that the materials ordered were in reality wanted before placing them in process.

Purchasing records. The personnel of the purchasing department is ordinarily divided into two distinct classes, those actually performing the purchasing function and those in charge of the maintenance of purchasing records. In large purchasing departments both these groups become of considerable size, with one or more purchasing agents in charge of the purchase of various types of commodities, and with a number of clerks in charge of the various record-keeping functions, over whom there is a chief clerk who reports directly to the head of the whole department. The work of the group under the direction of the chief clerk is of paramount importance in successful operation. Records of past transactions, as well as of current ones, are vital to intelligent purchasing. In almost no other place in management are records of what has previously happened more vital. Information files, with complete and detailed information concerning materials and vendors, can be made the very life-blood of the purchasing department.

One of the more important types of information which should be on hand, and readily accessible, is a list of manufacturers, dealers, or jobbers who are in a position to supply the articles which are regularly used, or who may be thought to be prospective bidders on any special commodities which may be required from time to time. All such information should be complete to be of maximum value. It should include the location of the plant and the sales offices, the names of the officers to be dealt with, freight rates, any necessary remarks with reference to the freight situation between the point of shipment and the plant, such as congested junction points which may delay the shipment, and whether the concern is in a position to fill orders from stock, or must manufacture them to order. Other items of interest on these firm record cards should be facts regarding the manufacturing capacity or usual supplying capacity of the firm, and the maximum size of the orders that they can handle. Catalogues may be arranged by cross-reference to this list.

A quotation file should be maintained which will have readily available past quotations by both successful and unsuccessful bidders. These files will ordinarily be composed of the returned "request for quota-

tions," which have been sent out originally by the purchasing department, and will be valuable in checking over any new quotations which may be received, in settling disputes concerning reasons for granting previous orders to other bidders, and as a general bird's-eye-view of the policy of the purchasing department with reference to the concerns which are invited to bid. This quotation file gives the complete history of all orders on which bids have been requested prior to the actual filing of any of these orders. The next group of records, the actual purchase records may duplicate some of this information, but this will not be harmful, inasmuch as when the information is wanted it will be most easily found as a quotation or as a purchase order, depending on the need at that particular time.

Purchase records are usually maintained in three ways in the most effectively run departments, namely, by firm name, by articles, and by purchase orders. The purchase records by firms include a sort of account for each firm with whom business is carried on. This record is used to check over receipts and invoices, as well as a record on which to base the issuance of future business. In maintaining this record of purchases by firms it is most essential that all discounts and datings be carefully noted, as these will serve as a check when purchases are next made from the company in question, and are quite as important as the quoted sales prices.

Purchase records by articles are useful in showing the trends of prices and in discovering whether or not bids that are received are high or low. This last is true particularly in the case of commodities and articles for which there is usually no stated "market." One error which is frequently encountered in this type of record and which must be guarded against is the placing of dissimilar commodities on the same card because of the incomplete description which is on the card or on the purchase order. This is just one more reason for making purchase orders extremely explicit. Slight differences in the article ordered may make the record of purchase by articles show fluctuations which are in fact not at all justified.

Purchase records are usually maintained in all purchasing departments by purchase order number, if in no other way. All shipments must ordinarily be marked with the purchase order number, and incoming goods are checked against the purchase order by the purchasing department prior to approving the invoice and sending it to the accounting department for payment. This type of purchase record usually consists of a retained copy of the purchase order, a copy which will ordinarily have spaces for office records which do not appear on the original of the order that goes to the vendor. Such notations will include, "approved for payment," "expense distribution," "partial receipt," etc.

Another type of record which greatly increases the effectiveness of the operation of the purchasing department is the tickler follow-up of orders outstanding. This consists merely of a file, wherein special copies of the orders or separate slips bearing the order number are placed, to be called to the attention of the designated person at a stated date after the papers are placed in the file. When these papers are called to the attention of the designated person, he makes an investigation to ascertain whether or not the material has been received, or what the progress has been in filling the particular order. By calling orders to the attention of a member of the purchasing staff at certain periods prior to the actual need of the material in the factory, it is possible to make certain that the material will be on hand when wanted, or at least that extra effort may be made by the purchasing department to secure it by the proper time. Thus the respect which the other departments of the organization hold for the purchasing department and its operating methods will be maintained and increased.

CHAPTER XLI

CLASSIFICATION OF BUSINESS DETAILS

Many phases of organization operation and control are assisted by the development of an adequate classification for the business. A classification is a detailed, orderly arranged list of all the items pertaining to the various phases of a business. Classification, under modern business conditions, is a necessity, and the merits and results of classification should not be confused with the merits of the various systems of symbolization which make the classification usable in the day-by-day operations of the business.

It will be recalled that classification is one of the basic steps in scientific methodology. A restatement of these steps may be made as follows:

1. Observe accurately all the facts involved.
2. Classify and combine all of the facts on the basis of some common relationship or relationships.
3. Interpret the relationships in terms of a law or statement explaining the observed relationships.
4. Test the formulated statement or law and note any deviations.

Classification *facilitates interpretation* and *ease* of *reference* of seemingly unrelated facts. Not only are known data rendered usable by classification but unknown relationships have been hypothecated in terms of logical interpolation of the known. Satisfactory wage rates for new operations have frequently been established by reference to classifications of similar work.

The beginning of classification work within a business usually marks the beginning of accurate knowledge concerning the various phases of the business and their interrelationships. When one considers the number and variety of records that are necessary in the modern organization, it becomes apparent that a definite classification of the data pertaining to the various activities is necessary. Otherwise, there are likely to be duplication and overlapping of work in the collection of such data. The establishment of a classification within a business makes possible the establishment of a system that makes record-collection routine.

The uses of classification development are as follows:

1. It clearly indicates the plan of organization, in that it shows the relationship of divisions and departments, and interprets the limitations of their activities.
2. It establishes a method for obtaining the information necessary for the operation and control of an effective accounting system; facilitates the collection of data pertaining to indirect expenses and manufacturing costs; and aids the establishment of monthly inventory balances of stores, materials in process, worked material stores, and finished products.
3. It aids materially in showing tendencies; thus a comparison of performance over a period of time for any operation or activity shows the direction in which this item is moving. A comparison of classified expense items invites managerial approval or action.
4. It aids in standardizing the arrangement of articles in storerooms and prevents the incorrect issuing of articles, as often happens when names or shop terms are used on the requisition.
5. It furnishes a means for routing and controlling material in process by accurately designating the materials, machines, workplaces, and operations entering into each process or component.
6. It makes possible the collection of detailed information relative to buildings and equipment.
7. It provides a logical system for the filing of all data.
8. It aids the development of standardization. The word is here used in the special sense of the determination of the best method or the best material to use for any given purpose under existing conditions, and strict adherence to that best as a standard until a better standard is found. Classification aids because in almost every instance in which classification is applied, it will be found that there are a large number of almost similar articles used for similar purposes. In order to reduce the amount of classification work, to say nothing of other reasons, there will be a tendency to reduce the number of items. This helps to create standards. When it is ascertained that an item is the best, it is adopted, classified, and recorded.

Basis of classification. A fundamental consideration in the determination of the basis of classification is the expected use to be made of the classification. A second consideration, unless it is definitely predetermined that the classification is for temporary use only, is the provision for expansion. Often a different basis will be used for a classification for a specific purpose of temporary duration than when the classification is for permanent use. There are many bases that may be used for

classification, depending somewhat upon the nature and purpose of the classification. A few of the bases for classifying raw material are illustrative, as follows:

1. Classification of materials by the nature of the materials themselves, such as liquids, solids, gases; acids, bases, salts; metals, wood, ceramics; etc.
2. Classification of materials by the use to which they are put or the purpose served, such as direct materials and indirect materials, mechanical rubber goods and automobile tires, tubes, and flaps.
3. Classification according to the location of the plant or department where the material is used. This method may be in use where two or more plants in the same general area are under the same general management but are operated as separate units.

The first classification above is by far more universal in its nature and is capable of indefinite expansion into a logical system. Such a system may be more complicated for a relatively small plant, but with large, complex institutions it is often a necessity. Classification on the basis of the use to which materials may be put may be simpler in practice in smaller organizations. To the mind of the average workman untrained in the techniques of classification this system has a strong appeal. It seems logical to him to associate the material with its use. Classification by location is similar in many ways to classification by use as far as the worker is concerned.

The base for classifying labor is another good illustration of the problem in industry. For cost purposes it is highly desirable to have the labor applicable to the product on which the labor is expended. Looking at it from a control angle, labor may be classified on the basis of being direct or indirect. In terms of the employment office, labor may be grouped under the heading unskilled, semi-skilled, and skilled. On the basis of job classification for wage payment the items of skill, length of training required, hazards, unsatisfactory working conditions such as the presence of heat, dust, or water, and wage customs, may all be combined to establish a graph along which the various occupations are placed. Regardless of the given base used for classifying any material, product, service, or persons, attention should be given to adequacy of the basis selected and whether or not it is capable of expansion to meet changing conditions.

Steps in the development of a classification. The first step in the development of a classification is that every element of the business must be listed with infinite detail, taking into consideration all existing departments, all materials in stores and in process, all finished products, all workplaces and machines, all operations performed, all fixtures and

tools, all buildings, and all possible sources of expense. After the preliminary data have been gathered, the subjects to be classified are divided and grouped into a number of main classes, each of which is designated by either a number or a letter, depending on the method used. Each main group is then subdivided or further described to the extent that is necessary. After each group and subgroup has been formed and carefully revised, the attaching of symbols to each item may be begun.

The cost of classification is heavy, although the return on the investment is large. Therefore, care should be taken to classify and symbolize no more of the business than will actually be utilized daily when the standard nomenclature has been built up. There are certain fundamental features of classification which can be used in almost every case, but there are others in which nicety of judgment must be exercised before deciding whether or not to incorporate them into the original classification. For instance, almost every plant has need for some control over its raw materials or parts in process in the storeroom. To secure this control it is necessary to establish a requisition method of withdrawal from the storeroom. As soon as this is introduced, standard nomenclature generally becomes a very useful mechanism, both for the location of the article itself in the storeroom, and for the abbreviation and simplification of the clerical work attached to the writing of the requisitions.

An example of when not to use too much classification occurs in almost any of the continuous or analytical industries which handle a single material from start to finish. In such a case an elaborate classification for routing, including identification of all materials in process, finished product, machines, and workplaces, might be expensive, burdensome, and unworkable. On the other hand, involved assembly industry is lost without a good routing classification. The classification of duties and functions of individuals has not been carried so far as the classification of the other branches of industry. However, in recent years considerable attention has been given to job classification [1] and some attention to the personnel audit which is based upon the careful classification of all jobs or occupations.[2]

A classification should be made as simple as possible. Care should be taken not to subdivide the main groups any more than is actually necessary; otherwise, the symbols will be long and possibly unwieldy. On the other hand, the simplification of the classification should not be

[1] See American Management Association, *Personnel Series*, No 39, 1939, pp. 17-22; also Industrial Management Society, *Occupational Rating Plan for Hourly and Salaried Occupations*, 1937.

[2] Ordway Tead and Henry C. Metcalf, *Personnel Administration*, McGraw-Hill Book Company, New York, 1933, pp. 267-279.

carried to such an extent that confusion or misunderstanding will result.

After a classification has been completed, it will be well to bear in mind that many unforeseen "kinks" will probably develop, and provision should be made for quickly investigating and correcting any trouble. A classification is useful only to the extent to which it is kept up to date. An accurate record of all persons holding copies of the classification should be kept, so that when changes are made in the original classification, arrangements can be made to have all additions and changes entered on all copies. This can best be handled by the Methods or Research Department, if one exists; or in some institutions the production control division has charge of this function.

Identification. Closely related to classification in industry is identification. As a matter of fact, it would be impossible to have a workable classification without a system of identification. The simplest form of identification is the use of the regular name for the article or service identified. This system may be satisfactory in a small institution having only a few items; however it is extremely burdensome, wasteful, and subject to error when applied on a large scale. Identification is accomplished also by the use of signs or symbols, numbers, letters, or a combination of these with words. In actual usage these name substitutes become quite as well known as the actual name itself. Probably the best known use of symbols, familiar to high school students, is the chemical formula.

Plants, buildings, production centers, machines, trucks, products, many parts, forms, various accounts, etc. are often assigned an identification other than their common names. Such a procedure promotes precision and accuracy and materially reduces the chance for error when once the identification symbols or numbers have been firmly established. The use of appropriate identification numbers greatly reduces the amount of clerical writing in connection with records of parts, materials, and operations. It is customary in production control to refer to the operations in sequence by appropriate identification numbers. The same is true of the machines upon which the various operations are performed. The use of numbers to identify labor operations and materials facilitates machine tabulation of cost data. An adequate system of classification and identification is both a convenience and a necessity in large-scale mass production.

Systems of identification. There are at least five systems in sufficiently general use to be worthy of mention, as follows:

1. Alphabetical—the use of a letter or a group of letters according to some predetermined scheme.
2. Mnemonic—the use of letters in some such combination that they

suggest the classification name of the particular item. Numbers may be combined with letters in the mnemonic system, particularly to suggest size or some generally accepted standard.

3. Numerical—the use of numbers to identify the particular item.

4. Signs—the use of symbols or signs to indicate items or operations. These have been extensively used in motion study techniques.

5. Combinations—the use of any of the above systems in combination with any one or all to identify a particular item, service, or operation.

Letters have been used extensively to identify buildings and departments. It is but a simple step to progress from the use of a single letter to combinations. Many of these have been worked out prior to the logical mnemonic system. For instance, Department A in Building B may be known as BA where the building is always written first. Where there is more than one similar department in a building, numerals may be added to indicate the different departments; thus BA may stand for a press room in a rubber plant where miscellaneous sizes of tires are cured and BA1 may indicate a press room where only one size tire is run, such as those tires used on the Ford or Chevrolet. Drawings, parts, cost classifications, etc., may also be designated by letters. Unless a logical system is worked out letters become unwieldy in the case of a large institution having many items.

Frederick W. Taylor and his associates contributed the mnemonic system of identification to scientific management. The most valuable phase of this system is that it may be expanded to classify and symbolize every single phase and item of a business in a way that makes the nomenclature a unified whole without repetition of symbols. A close second, and in the opinion of many the most important, is the fact that the mnemonic system, as its name suggests, aids the memory by suggesting the classification name. To illustrate, ML signified *mill*, GR indicates *grind*, AM stands for *material accounts*, and DP stands for the *punch press department*. This system is of such general application that it is discussed in detail in Appendix A.

There are at least three systems that use numbers for identification—the use of consecutive numbers, the assignment of certain groups of numbers to certain well-established classifications, and the Dewey-Decimal System. The use of consecutive numbers is simple and may be satisfactory in a limited way for such things as general notices to the plant, etc. Where the number of items is great, consecutive numbers are not satisfactory unless accompanied by a cross-indexing system for ease of reference. The assignment of certain groups of numbers to established classifications is a well-known system and when scientifically

worked out is capable of indefinite expansion and is entirely satisfactory. This system is widely used in accounting systems. A simple allocation of numbers might well be as follows:

1. Department numbers	1–199
2. Asset accounts	200–299
3. Liability accounts	300–399
4. Revenue accounts	400–499
5. Expense accounts	500–

By a proper combination of numbers a logical system can be built up that soon becomes generally known throughout the organization. Certain positions indicate specific classes or groups. For instance, the first two numbers usually indicate the class of machine and the last two the machine number within the class, as follows: 0501—automatic feed turret lathe, 1; 0502—automatic feed turret lathe, 2, etc. Every phase of the enterprise can be readily classified by proper analysis and thought. (See Appendix A for a detailed explanation of this system.)

The Dewey-Decimal System is best known in the field of library science. It has been used in industry but has few if any advantages over the use of assigned numbers to certain classifications and has the disadvantage of increased possibility of error through misplacing the decimal point. This error may be obviated by omitting the decimal point and indicating its position by the use of zeros, thus 015 being used instead of .015. However, in such cases as 00019 it is very easy to omit one of the zeros.

CHAPTER XLII

CONTROL OF INVENTORIES

Importance of inventory control. The business survival of an industrial enterprise may readily rest upon the effectiveness with which it controls its inventories. This is particularly the case if the purchasing function be considered a portion of inventory control. The stores and partly finished stock on hand often represent from a quarter to a half of the capitalized value of the business. Wastage, obsolescence, or poor purchasing may quickly wreck a concern through inventory losses. Poor control of materials is frequently accompanied by poor storeroom administration in a way that may easily throw out of balance any operation programs which have been adopted.

If the business be budgeted, or if only sales and production programs be adopted, it is essential that an inventory control be set up which will provide material as it is needed, and will not at the same time tie up large sums of capital which might be used in furthering the operating program in other ways. No complete system of budgeting can be successful unless effective inventory control has preceded it. Otherwise production obligations cannot be met by the manufacturing department, at least within the allowed cost. The daily routine of cost accounting, with or without an administrative budget, demands that material be controlled accurately and intelligently.

Types of inventories. There are four distinct types of inventories in most industrial enterprises with two or more subdivisions under each heading in most cases. The main subdivisions are: (1) raw materials, (2) material in process, (3) finished products, and (4) supplies. Supplies are often classified under raw materials. To the individual manufacturer, raw material consists of all items which go into his product on which he has not performed operations such as brass rods, sheet metal, or parts purchased from outside suppliers. Material that has not undergone any major change since its receipt is usually classified as raw material. *Material in process,* as its name implies, is material that has been processed in part but as yet is not ready to be shipped to the consumer. Materials in process may be in any stage of completion from the material issued by the stores department but as yet having no operation performed upon it to finished material still held in the production unit ready to be turned over to the stockroom or not yet reported to the control division as ready for shipment. Finished products are

those that have been completed and are ready to be shipped to the consumer. Where there is a separate stockroom or shipping department, the product is considered a finished product when it is turned over to this unit. Supplies are all of the materials that are used as aids to production but are not a part of the product itself. Such items as oil, sandpaper, polishing compound, etc. come under this heading. In some cases small tools such as knives, hacksaw blades, etc. may be classified under the general heading of supplies.

Sources of loss from improper control of inventories. The sources of loss from improper control of inventories include the costs of purchases in excess of needs, the costs of slowing up production by not having material available when wanted, and losses through improper diversion of material, either wastefully or willfully. The losses due to excess purchases provide a continual pull toward small stocks, and the losses due to production tie-ups provide a continual pull toward large stocks. It is between these two conflicting forces that a balance must be struck. The losses due to improper diversion of material necessitate the maintenance of adequate material records.

Excess purchases will bring with them not only the losses in interest and ability otherwise to utilize tied-up capital, but will bring with them direct loss from depreciation on the material and frequent loss from obsolescence, which may be so large that high-priced goods may have to be sold for the price of waste or junk. Particularly in standard products, graphic charts provide a means of eliminating expensive over-purchases. Over-ordering is costly on a stationary material market, whereas in a falling market it conceivably may lead to bankruptcy. Damage and deterioration due to overstocking must be reckoned with. Excess quantities frequently encourage poor storing, and unnecessary transporting and handling within the plant, with consequent damage to materials and increased costs. Furthermore, many articles, such as foodstuffs, drugs, and rubber, deteriorate with age; this may mean a total loss of all materials purchased above relatively current requirements.

To promote smooth factory operation and to prevent the piling up of idle machine time, proper material must be on hand when it is wanted. If material is not available in continuous process industries it may result in the temporary shutdown of a large portion of the plant. In any plant where operations, machines, and orders have been finely balanced, this will mean untold confusion. The storeroom is a service department and prompt delivery of materials to the manufacturing floor is all-important.

Improper diversion of materials through excess use is a commonplace in many plants. It has been eliminated in as many others. Frequently material is thrown away, lost, or damaged while in process, without any

record providing a check. One cause of this condition is found if the plant allows excess material to remain in the production department to be used on future orders, rather than to be returned to the storeroom. This is a common practice in fabricating plants where cartons of raw material, the product of other plants, are used extensively.

In such shops, issuances are not closely checked in the storeroom or elsewhere against production orders, and thus standards of consumption are for the most part lacking. In other shops, if the workman damages material he can usually receive additional material from the storeroom without much questioning.

Direct thievery, although often important, is usually the smallest source of loss from improper material control. In some plants workmen have uncontrolled access to the storeroom. To allow this sometimes results in startling losses, especially if the material is of a type that is easily disposed of to pawnshops or to junk dealers or can be used in the workers' homes. To protect materials from thievery is an obvious function of any stores-control system.

Good inventory control which, together with good storeroom and purchasing department operating methods, can eliminate most of these losses, requires the following steps: (1) the fixing of minimum quantities, or ordering points, and of maximum quantities, or amounts to order, on all materials; (2) arranging a method for allocation of material to orders in process or contemplated; (3) creation of stores accounts, which will control the storeroom and not be controlled by it.

Setting a maximum and minimum on materials. To set a maximum and minimum inventory will be advisable, regardless of the number of articles of stores or worked materials to be controlled. If an ordering point and ordering quantity be set, the maximum inventory will automatically be determined. The ordering point usually is not the minimum inventory, but somewhat higher than the danger point or minimum. It is sufficiently above the minimum inventory to allow for the issuance of the production or purchase order and to allow for fabricating or processing in the plant or for delivery by a vendor in case of purchase. For control purposes the ordering point is more important than the minimum inventory. The maximum inventory will be approximately the sum of the ordering quantity and the minimum inventory. It would exactly equal these two quantities if the ordered material were delivered just when the minimum inventory was reached. Such precision seldom is realized in practice, which means that the maximum inventory is nearly always somewhat higher than the theoretical figure. The same holds true with respect to the minimum inventory. Under actual operating conditions the inventory may actually fall below the minimum. This is a danger point and is a signal for a close follow-up to avoid

a tie-up in production. If there are large numbers of articles it will be well to divide them into broad classes, the individual articles in which all will have maximum and minimum quantities controlled by the same factors. The factors which determine the maximum and minimum point for each article of stores may be divided into two broad groups. First is a group of general factors applying to all articles carried, such as general business conditions and the prospects of the particular business. Second is a group of factors directly dependent on the article itself. These are somewhat intertwined with the first group, but may cause special treatment for some particular material.

Predicted consumption during a given period, as indicated by general market conditions, by the state of health of the concern, and by the announced firm policy toward lines being manufactured, forms a basic consideration which is reflected in all other factors. In periods of increasing production and great market demand, ordering quantities may be raised, and the minimum frequently must be raised. If business conditions are the reverse, the minimum must be lowered generally. A major factor to be considered at the same time is the probable trend of prices in the commodities to be purchased. This may or may not follow general market conditions. Two more general factors peculiar to the business are the condition of finances and available capital in the business itself, and the extent of storage facilities which are available. In considering this latter factor, the cost of new storage facilities, or interest thereon, must be balanced against the cost of carrying inventories which the present storage facilities can handle. Changes in the line of product, particularly standardization programs in process of development, may easily be the most important of these factors which are general to all materials carried.

There are a number of factors peculiar to each article which must therefore be considered separately for each: (1) The consumption of that article over a past period must be considered in connection with the general factors just mentioned. (2) There is a profitable manufacturing or ordering quantity. The latter, particularly on special goods, implies the profitable manufacturing quantity in the vendors' plants. These can best be determined by experience and quotations. Ordering quantities must always be set with due regard to commercial usages. (3) The probable depreciation or obsolescence will influence the amount that should be carried in stock. (4) On small, inexpensive items, the clerical cost of ordering, receiving, and payment of bills may cause the ordering quantity to be raised. (5) The last factor is the time necessary to secure the article after requisitioning. On purchased goods for which there is a regular source of supply, this will include the delivery promises of the vendor, and the time taken to transport the article to the user's plant.

On worked materials, it will be dependent on the time taken to work up a manufacturing order for the ordering quantity within the plant itself. The work situation in the plant will greatly influence the time required for the plant to produce a given part or assembly.

The first step in inventory control has been taken when the ordering point and ordering quantity have been set. On standard products, made to a manufacturing schedule, these may often be set in a much simpler way by setting production requirements for a given length of time as the ordering point, and production requirements for another stipulated time as the ordering quantity.

Formula for computing ordering quantities. A formula that is satisfactory for all plants has as yet not been developed. This is not essentially different, however, from many other phases of scientific management. Detailed methods of personnel control, production control, record-keeping, etc. can seldom be taken over by one concern from another and used successfully without first undergoing adjustments to meet the local situation. Even within the same plant, routines must be modified to meet the requirements of the specific condition to be served. The same holds true with reference to the formula used for the determination of the economic lot size to be manufactured. One large manufacturer in Chicago developed a formula for the control of manufacturing lot sizes and then the management reduced these lots arbitrarily 25 per cent as a matter of being conservative and to reduce inventories. The critic would say that this is not scientific; and this is true. On the other hand, this procedure has much to commend it over no method of control other than mere custom or past experience that has not been critically evaluated.

The minimum unit cost for a given part or material is the desired goal of ordering on the basis of the economic lot size. This point occurs when the total preparation costs for the quantity to be produced are equal to the total average inventory carrying charge.

The formula used by the manufacturer referred to above is as follows:

$$Q = \sqrt{\frac{2PR}{CI}}$$

in which

Q = economical lot quantity in units,
P = preparation costs in dollars,
R = requirements in units on an annual basis,
C = cost of part in dollars per thousand units,
I = carrying charge in per cent.[1]

[1] See John MacDonald Gifford, *Procedure Control of an Electrical Manufacturing Organization*, A Masters Thesis, School of Commerce, Northwestern University, 1939, p 76.

The preparation costs are made up of two factors: namely, (1) the ordering cost, which includes all planning and clerical costs, and (2) the machine set-up cost. The requirements in units on an annual basis are usually taken from the master budget or master schedule. This figure can be only an estimate. The carrying charge (I) expressed as a per cent of the cost of the economical lot includes such items as interest on the investment in inventory; taxes; stockroom expense—storage, etc.; depreciation; and obsolescence. This carrying charge is frequently as high or higher than 20 per cent.

Data regarding the economical lot size for a given concern are frequently expressed in the form of a chart from which the desired lot size can readily be taken. As stated at the beginning of this discussion, the economical lot size formula is not one of universal application but must be derived from the facts in a given situation. In any case the use of the economic lot is of value primarily when ordering for stock and not in continuous manufacturing.[2]

The balance-of-stores sheet. The other steps in inventory control are taken through the use of a balance-of-stores sheet, such as that in Fig. 138. Such a control sheet actually controls the storeroom, and is not merely a record of material on hand of a perpetual inventory. Many forms of balance-of-stores sheets have been devised to meet individual operating conditions, but all that give the necessary control are uniform in providing four important balance columns, which actually, together with the maximum and minimum which have been set, control the inventories. These balance columns (Fig. 138) are headed "Ordered," "Balance on Hand," "Apportioned," and "Available." Apportioned is frequently called "Applied on Orders." In either case it governs that material which has been allocated to given manufacturing orders, but not yet withdrawn from the storeroom.

The Apportioned column insures that material will be on hand when wanted for manufacture, and successfully eliminates the practice of relying on the same lot of material to fill two orders. Unless materials are applied as delivery dates are stated and schedules for manufacture are prepared, it becomes likely that the planning department will rely twice upon the same materials. The Available column indicates the amount of material which is still available for assigning to orders. The last balance in this column is continuously compared with the stated minimum to determine when to order, rather than the balance in the On Hand column. Unless this were the case, goods might be on hand well above the minimum, but might be ordered into production tomorrow for orders

[2] See Henry P. Dutton, "Inventory Control," *Factory Management and Maintenance*, August, 1935, pp 5, 79; also Fairfield E. Raymond, *Quantity and Economy in Manufacture*, McGraw-Hill Book Company, Inc, New York, 1931, p. 5.

already in the plant, to such an extent that the danger point might be reached and passed long before a new supply of goods could be secured. This balance sheet provides a continuous check as to its accuracy, inasmuch as Column 1 (Balance Ordered) plus Column 3 (Balance on Hand) should always equal Column 5 (Balance Apportioned) plus Column 6 (Balance Available) after any transaction has been entered.

To indicate clearly the operation of this sheet, which is basic in inventory control, the accompanying illustration will be explained. The article, 2-inch hollow steel tubing, quality, specification "B," has had its minimum set at 800 feet, and the ordering quantity at 4000 feet. The maximum is therefore 4800 feet. On June 14 when this sheet was opened, there was on hand a balance of 1500 feet, which was also available to be apportioned. The unit value of this material, as brought forward to this sheet, was 35 cents per foot. The first transaction was an issue to the shop of 600 feet, without previous apportionment. The next transaction was a similar issue of 300 feet, which brought the Balance Available below the minimum, and hence caused the entering of an order for 4000, the ordering quantity. Upon ordering, this amount is considered immediately available for apportionment, although it is not yet in the plant, and hence not ready for issue. (On commodities or in times when prompt delivery cannot be expected, it is unwise to consider material which has been ordered as available until it has been shipped.) On July 20, production order No. 3982 was entered, calling for 1200 feet of this article, which was immediately apportioned to this order, and taken from the Available column, although the order was not yet to be placed in production. On July 28, 300 feet of this amount was issued to the shop for production, and therefore deducted both from the Balance on Hand and the Balance Apportioned. Next, on July 30, the material on order arrived, and was deducted from the Balance on Order, and added to the Balance on Hand. The new material cost 40 cents per foot, and there was so little of the old supply on hand that the unit value was increased to 40 cents also. The next transaction called for the issue of 600 more feet of the material apportioned to production order No. 3982, which was deducted from the Balance on Hand and the Balance Apportioned. On August 20, production order No. 4071 was received, making necessary the apportionment of 1800 feet, making the Balance Apportioned 2100 feet, and the Balance Available for apportionment 1600 feet. On August 22 the remaining 300 feet apportioned to order No. 3982 were issued to production, again reducing the Balance on Hand and the Balance Apportioned. On August 27 an unexpected order (No. 4124) was received, calling for immediate production of articles requiring 1200 feet of tubing. This order was immediately placed in production, the full requirements

KIND OF UNIT *Foot*

BALANCE OF STORES

DESCRIPTION *2" Hollow Steel Tubing, "B"*

MINIMUM *800*

QUANTITY TO ORDER *4000*

SYMBOL **SST2B**

1 ORDERED BAL.			2 RECEIVED			3 BALANCE ON HAND			4 ISSUED				5 APPORTIONED BAL.			6 AVAILABLE BAL.		
DATE	ORDER NUMBER	QUANTITY	DATE	QUANTITY	VALUE	QUANTITY 6/14	VALUE	UNIT VALUE	DATE	ORDER NUMBER	QUANTITY	VALUE	DATE	ORDER NUMBER	QUANTITY	DATE	QUANTITY	. REMARKS
						1500		.35								6/14	1500	
						900			6/18	3726	600	210 00					900	
						600			7/10	3914	300	105 00					600	
7/11	1487	4000														7/11	4600	
													7/20	3982	1200		3400	
						300			7/28	3982	300	105 00		"	900			
		0000	7/30	4000	1600 00	4300		40										
						3700			8/8	"	600	240 00		"	300			
													8/20	4071	2100	8/20	1600	#4071=1800
						3400			8/22	"	300	120 00		3982	1800			
						2200			8/27	4124	1200	480 00					400	
8/28	1516	4000														8/28	4400	
						1600			9/11	4071	600	240 00			1200			
		0000	9/14	4000	1520 00	5600	2160 00	39										

FIG. 138. Balance-of-stores Sheet.

being issued to the shop on the same day that the order was received. This again brought the Balance Available below the minimum, and an order was placed the next day for 4000 feet (despite the fact that there still remained 2200 in the storeroom, 1800 feet of which, however, was apportioned to order No 4071). On September 11, 600 feet were issued to the shop for order No 4701, thereby reducing the Balance on Hand and Balance Apportioned columns. On September 14, the 4000 feet on order arrived, at a unit price of 38 cents per foot, thus increasing the Balance on Hand to 5600 while the Balance Available for apportionment remained at 4400. The total value of the 5600 feet on hand was then $2160. This series of transactions illustrates the more important entries made upon this sheet, and shows how intelligent control of inventories is made possible, allowing in advance for all production

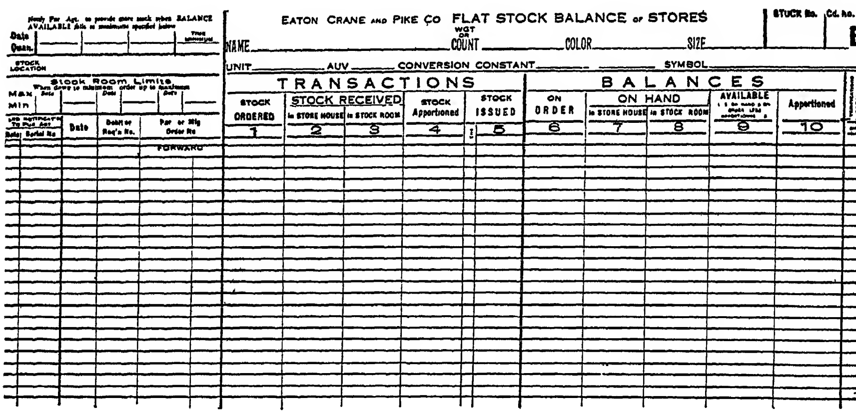

EATON CRANE AND PIKE CO FLAT STOCK BALANCE OF STORES
NAME
COUNT
COLOR
SIZE
UNIT
AUV
CONVERSION CONSTANT
SYMBOL
STOCK LOCATION
Stock Room Limits
MAX
MIN
Date
FORWARD
TRANSACTIONS
STOCK ORDERED 1
STOCK RECEIVED
In STORE HOUSE 2
In STOCK ROOM 3
STOCK Apportioned 4
STOCK ISSUED 5
BALANCES
ON ORDER 6
ON HAND
In STORE HOUSE 7
In STOCK ROOM 8
AVAILABLE 9
Apportioned 10

FIG. 139. Balance of Stores Sheet, Eaton, Crane and Pike Company, Pittsfield, Mass.

needs without unnecessarily tying up capital in material on hand. It will be noted that, after each transaction, Column 1 plus Column 3 equals Column 5 plus Column 6.

In Fig. 138 there are but two transaction columns, 2 and 4. Frequently there are transaction columns provided for each of the balance columns, as in Fig. 139. This sheet completely separates transactions and balances and is particularly valuable when used for machine posting. It also indicates a method of splitting balance columns to give detailed information desired. There are a number of ways in which these columns may be split without in the least changing the basis of operation of the balance-of-stores sheet. Thus the Available column may be split into "Available for Apportionment" and "Available for Issue." This would give immediately, without subtraction, the amount of stores actually

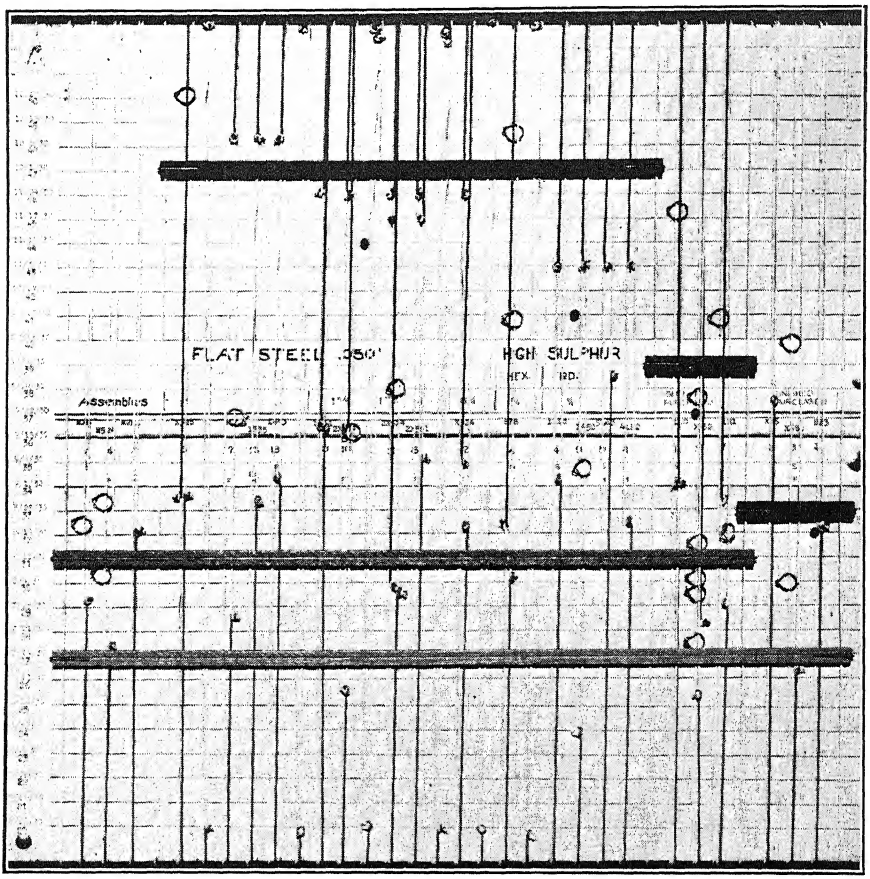
on hand which might immediately be issued without interfering with apportionments already made. The Ordered column may be split into divisions such as "Ordered but not Acknowledged," "Ordered and Acknowledged" and "In Transit." If this is done materials may not be deemed available, if it is so desired, until they are entered in one of the latter two subdivisions.

The balance-of-stores sheet may be operated by any division of the business which the organization may feel is best from its standpoint. They may be kept in the general accounting office, in the storeroom, or in some portion of the production office, preferably the planning department. Since the operation of the balance-of-stores sheets is primarily a function involving thinking ahead, and since it is so closely bound up with control of production, the most logical place to operate it is from a planning department if there be one.

Visual control of inventories. The L. C. Smith and Corona Typewriters, Inc., of Groton, New York, has developed a visual method of controlling raw materials and finished parts inventories. (Fig. 140.) This control board is 7½ feet long and 6½ feet high. The horizontal lines running across the board represent weeks. These lines are numbered from the bottom up by attaching a cardboard strip to the left side of the board. This strip also has the date by each line. Running vertically are a series of sets of different colored strings. These strings run clear around the board and are separated from each other by brads in the top and bottom board spaced ¼ inch apart. Each string running around the board is composed of two parts, one-half of the length is white and the other half is blue for the right string, red for the middle one, and green where a third string is used in the set. Where the colored string is tied to the white string a knot is made. These knots as they are moved up or down the board graphically portray the status of the inventory. Across the face of the panel and outside of the strings are three horizontal wooden sticks about ¼ inch wide and ⅛ inch thick and about 3½ feet long. These three sticks are clipped at the ends to the same strings so that they may be raised or lowered as a unit. The top stick is painted green, the middle one yellow, and the bottom one blue. The bottom stick is located on the board at the height that corresponds with the current calendar week and is moved up one space each week. The yellow or middle stick is located at a 4-week interval above the current week. This is the period allowed the planning department for issuing of manufacturing orders, bills of materials, instructions, etc. The third or top stick serves as a signal to the inventory clerk to place an order on the purchasing department for the stock in question when it, in its upward movement, overtakes either the green or the red

knot.[3] The horizontal cardboard strips thumb-tacked to the board about halfway up bear the information about the identity of the stock and its use.

The position of the blue knot indicates the net available inventory



Courtesy L. C. Smith & Corona Typewriters, Inc.

Fig. 140. A Close-up of a Sample Control Board Used by the L. C. Smith & Corona Typewriters, Inc., Groton, N. Y.

in process and in finished parts stock in terms of production requirements for weeks.[4] The distance between the blue knot and the red knot

[3] The third stick is located above the second stick a distance equal to the interval required by the purchasing department to place an order and secure delivery of the material. It is usually from 8 to 16 weeks.

[4] The entire visible inventory control is in terms of time not individual units or physical quantities. The numerical value of each week's requirements will change whenever the schedule changes.

is a measure of the raw material on hand and available for manufacturing the part. The distance between the red knot and the green knot represents the material on hand that must be slit or straightened before it is ready for use in manufacturing parts. (The green string would not be used for material that does not require an operation to be performed on it before entering into the production of parts.)

When the planning department orders additional parts produced, this information is indicated on the blue string by placing a nickel-plated clip a distance above the blue knot equal to the number of weeks' supply covered by the order. When this supply is received, the clip is removed and the blue knot is moved up to show the increase in finished parts inventory. The inventory control clerk notifies the planning department to place the above order for parts when the second or yellow stick overtakes the blue knot. Whenever material is ordered straightened or slit preparatory to being made available for manufacturing parts, the red knot is moved up to correspond to the number of weeks' material thus made available for production. When the top or green stick overtakes the green knots (or red knot if the green string is not being used) this is the signal for the inventory control clerk to place a requisition with the purchasing department for this material.[5] This requisition states the quantity being used weekly, but the purchasing department determines the quantity to be ordered in multiples of weekly usage. When the purchasing department places the order with a vendor, the inventory control clerk is notified, who places a black enamel clip on the green cord a distance equal to the number of weeks supply ordered. The green knot is moved up to replace the clip when the material is received. The height of the green knot (or red knot when the green cord is not used) indicates the total inventory of finished stores, parts in process, and raw material in terms of the number of week's production of finished parts.

Figure 141 shows the room in which the visible inventory control boards are kept. It is possible to add to the detail of the information presented by the board by the use of additional clips and various colored pins.

Control of supplies. It is essential that the same care be exercised in disbursing supplies that is used in issuing regular production materials. This is true particularly of such items as sandpaper, knives, and other items that can readily find their way into workers' lunch boxes. Frequently there are special storerooms for maintenance supplies as well as for office supplies. Both of these storerooms may not have sufficient calls to require a full-time storeroom man. In such cases the depart-

[5] The inventory clerk places a round-headed yellow pin by the green string at the desired delivery date for the material. This pin is removed when the purchasing department notifies the inventory control clerk that the order is placed.

ment clerk or someone in the organization may be delegated to this task for part time. A very important function of the storekeeper of supplies (the same also holds true for regular production materials) is the preparation of a periodic summarized report of slow-moving or obsolete materials. This report may well be duplicated and sent to all parties who may aid in disposing of this material. Frequently slight adjustments may make possible the using of obsolete material or the temporary substitution of a slow-moving item for a regular one. A close control over repair materials serves as a real aid to the purchasing department and frequently prevents over-ordering. Again it may avoid an expensive delay by having certain items available that are regularly called for.

Courtesy L. C. Smith & Corona Typewriters, Inc.

FIG. 141. Visible-index-inventory Control Room, L. C. Smith & Corona Typewriters, Inc., Groton, N. Y.

Position of inventory control in the business. No method for the control of stores is a substitute for business judgment. In fact, judgment must be carefully exercised in carrying on the control methods just described. No methods as yet devised will automatically increase a minimum on a rising market or decrease it on a falling market. They provide a useful tool for the management and are a means to an end. Together with the balance of stores sheet, they form a very satisfactory basis for good inventory control. They must be supplemented by other management steps.

CHAPTER XLIII

STOREROOM OPERATION

Types of goods stored. Manufacturing establishments are required to provide storage for three main types of goods:

1. Raw materials, properly termed "stores." These include supplies, or goods used only indirectly in production.
2. Partly finished materials, or stores on which some work has been performed. These are usually termed "worked materials," and may include finished components awaiting assembly or shipment to customers as replacements.
3. Finished product awaiting shipment, properly termed "stock."

Storeroom arrangement and operation must take into account the varying problems presented by these separate classes of goods. The term "stockroom" is often used to refer to the place where finished goods awaiting shipment are stored.

Location of the storeroom. In considering plant layout it was shown that the storeroom should be centrally located with respect to the production floors on which the material is used. This idea of a central location has been overemphasized in some plants. They have felt that centralization means that there can be but one storeroom, and they have defeated the very purpose at which they have aimed, namely, decreasing the expense incident to handling and rehandling material. The storeroom may consist of one room, one building, or a main storeroom with subsidiary storerooms advantageously located for the storage of special materials or materials for particular departments. The nature of the industry, the nature of the material, the site occupied, the situation and size of the buildings, and the arrangement of departments within the building must determine storeroom location. For instance, with bulk materials, ease of receiving through the use of gravity may place the storeroom far from the point of use of the material, which may be reached through the use of overhead cranes or conveyors at a smaller cost for small lots of materials than for the large lots in which the materials are received. The growth of material-handling equipment has made storeroom location more flexible, as such equipment can be used to transport materials either to subsidiary storerooms or from a central storeroom to operating departments.

The location of the storage space will depend on the nature and value of the materials to be stored and the rapidity with which amounts will be received and issued, as well as upon the point at which they will be placed in manufacture Material such as paper pulp is too bulky and used too rapidly to be stored in bins. However, the storage problems relating to such materials can well be studied. For instance, paper pulp, instead of being stored in huge piles, involving rehandling when needed, can be placed on platforms to be picked up by transfer trucks, each platform containing a standard quantity properly tagged to indicate lot numbers and specifications.

Heavy materials generally must be stored on the ground floor, whereas material that is light can be easily handled and can be fitted into almost any location that is otherwise desirable. Materials that are easily broken require facilities for protection and this protection must take precedence in the fixing of the storage place. Similarly, valuable material necessitates not only consideration of location but of safety. Some articles can be stored only under particular temperature conditions, and the storage place must be fixed with temperature regulation in mind. Inflammable material often demands a separate storage space that not only will protect the material itself, but also will reduce the fire hazard for the remainder of the establishment This may mean that a separate building will have to be erected, or a sort of fireproof vault provided within the storeroom, possibly communicating with the remainder of the storeroom through double fire-doors.

Any plan for the location of a storeroom must be flexible enough to allow for growth and other changed conditions arising over a period of years. If such conditions cannot be foreseen, or if the material stored will be used only for a short period, it may be profitable to consider the construction of temporary storage conditions that can be changed readily.

Storeroom layout. The area to be provided for storage purposes will have been worked out during the study of the location of the storeroom. Too much space will add to the indirect cost of storing the material. On the other hand, insufficient area will increase costs because of the congestion resulting. Lack of space granted the storeroom will often lead to a reduction of the quantities that may be carried, so that production is seriously hampered. The amount of storage space to provide is easily determined where a standard product is being manufactured, but not where numerous products of varying kinds are being produced.

The physical arrangement and layout of the storeroom involves allotting space for more than the actual storage of the goods. For smooth storeroom operation it is necessary that a section adjoining the entrance to the storeroom be reserved for the receipt of material as well as for its inspection prior to storage. Also, space must be provided for material

withdrawn for issue to the production floors, but not yet removed from the storeroom. This will enable the man in charge of the storeroom to work up his issuances in advance, in order that there may be no delay when the goods are actually required.

As in the layout of production floors, one of the most essential features of storeroom layout is to provide adequate aisles and passageways. These will permit materials to be brought in and taken out in the most expeditious manner. In the case of bulk storage, the storage areas and aisle spaces may be marked on the floor with paint. The layout of aisles will vary according to the needs of each storeroom, but in general it may be said that main aisles should allow the passage of two trucks and should vary from 6 to 8 or more feet in width, whereas other aisles will

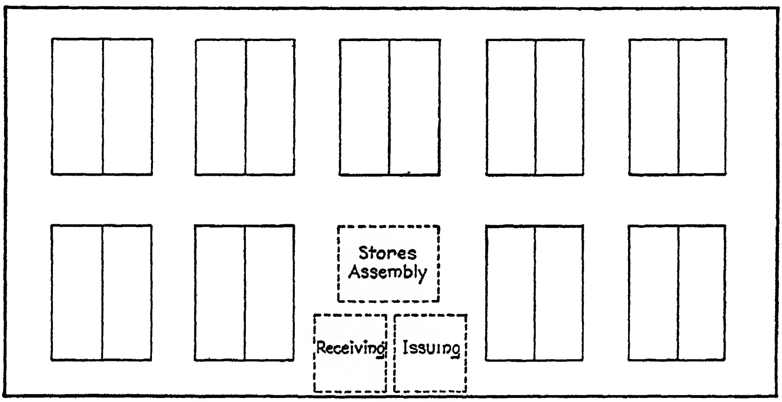


Fig. 142. An Effective Storeroom Layout. Windows will be in exterior walls opposite aisles.

usually have to allow for only one truck. In blind aisles running up to a wall, allowance may have to be made for the turning of the truck. Where the articles stored are of such a nature that they are generally carried by storesmen, the width of the aisles between the rack has been standardized at 30 inches in some storerooms. Figure 142 indicates the proper relationship of aisles to storeroom layout. The desirability of a central location for receiving and issuing, as well as assembling stores for stowing or issuing, is also shown.

Arrangement of material in the storeroom. The arrangement of the material within the storeroom will depend largely on the articles to be handled, the use to which they are put, and the classification which has been developed. One of the chief advantages of a well-developed classification is the aid that it gives in storeroom operation. Before the storeroom can be arranged, it is essential that there be established a systematic arrangement and designation of the material to be handled. Regardless

of whether the storeroom is arranged by classification or not, this will prove to be of value in arrangement. There are two main ways of arranging a storeroom: (1) directly by classification; (2) by index. Both are widely used.

If material is arranged by classification, it should be stored in the classification order. If the mnemonic system is being used, the first racks should include all those articles whose symbols begin with F, or whatever is the first letter, and the last racks should have stored on them those articles whose symbols begin with W, or whatever the last letter may be.[1] All intermediate racks should be alphabetically arranged, and a system should be developed for the alphabetical arrangement of each of the racks themselves, so that an article of stores may be found in the rack as a word may be found on the page of a dictionary. Bulky goods which cannot be stored by symbol are put in a convenient place, and a tag is hung at the point where the symbol would appear on the racks, giving the location of the material.

This arrangement of materials may be best illustrated by indicating the way in which it might be worked out in a particular plant. At the end of each rack on a central aisle, keyboards are placed which indicate the range of the contents of the rack. For instance, one of these keyboards might read SVZM-SVZY. This would immediately indicate that all articles of stores whose symbols were alphabetically between these two could be found in this rack, and this fact would be used in much the same way that the tabs on the side of a dictionary are used in finding the approximate location of a word. Each rack is divided into divisions, and these into sections and subsections, as is indicated in Fig. 143, which is an illustration of a main division. In stowing and locating material, each division is read separately, beginning with the upper left-hand corner (Section A), then across to Section B, down to Section C, and so on until Section H is reached. The subsections in each section are read in the same manner, the top row being read clear across before the next row below. Thus, in arranging stores by classification, the symbol of the article in the upper left-hand subsection of Section B would immediately follow the symbol of the article in the lower right-hand subsection of Section A. This whole arrangement makes easy the finding of an article without walking up and down in front of the rack.

Consider an issue for fifty of an article symbolized as SV3/8 × 1¼Z2M. Since the keyboards on the ends of the racks show the range of the articles stored in the racks by letters only, the figures may be disregarded for the time being, and SVZM will be looked for. This we shall quickly find to be in the rack mentioned above, namely, SVZM-SVZY. We then proceed to look through this rack for SVZ2M, which

[1] See Chapter XLI, "Classification of Business Details"; alse Appendix A.

we would immediately see is in a division near the beginning of the rack because the symbol is a subdivision of the first symbol on the keyboard of the rack. Having found this division of the rack, it is but the matter

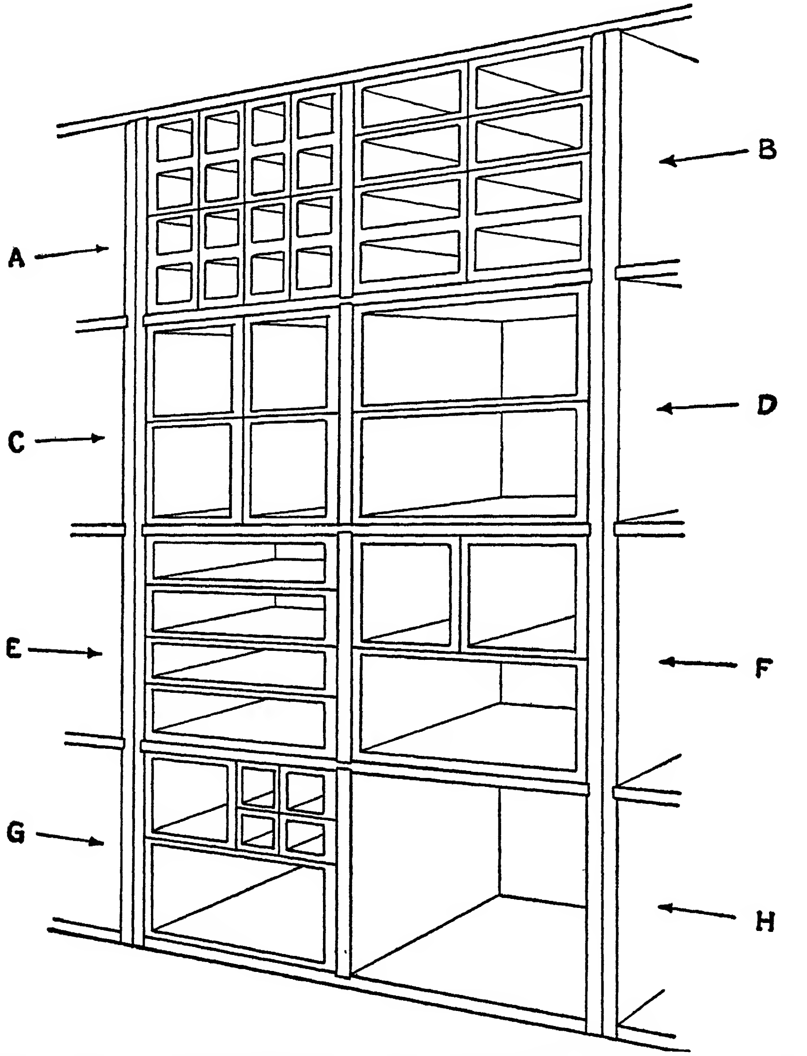


FIG. 143. Storeroom Bin Arrangement. Flexibility gained by the use of wooden bins.

of a moment to locate the particular section and size of screws desired in this instance, namely, $3/8 \times 1\frac{1}{4}$.

It is almost impossible for one unfamiliar with this arrangement to realize the ease and speed with which material can be located under this system. It is particularly valuable with small parts and for the storage

of forms and office supplies. A storeroom having its material so arranged is not dependent on one man's recalling where he had placed certain material. The plant would not be greatly handicapped even if the whole storeroom force were to leave suddenly. However, arrangement by classification can be utilized only where there is no rapid change in goods handled. Under other conditions it is not advantageous, because it causes continual rearrangement of the storeroom. Under any circumstances it has certain very definite disadvantages: (1) A large amount of space (20 to 25 per cent) must be left in each portion of the rack to allow for expansion. (2) The goods most frequently issued cannot be placed near

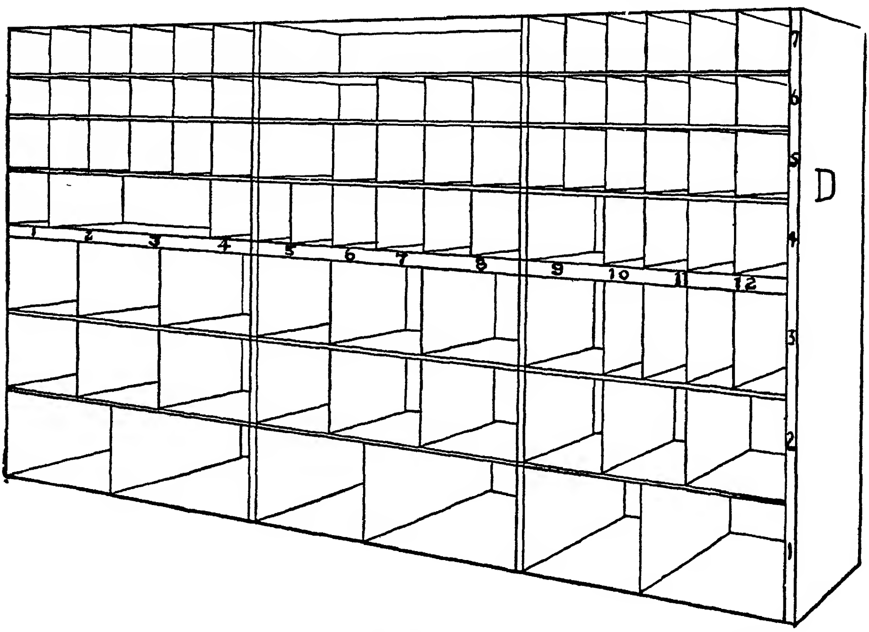


FIG. 144. Storeroom Bin Arrangement. Steel bins arranged by index.

the issue window without breaking down the scheme of arrangement. (3) Certain goods, such as unwieldy materials or very heavy articles, can under no circumstances be stored exactly by symbol.

The second successful method of arranging a storeroom is by index. The materials in the storeroom are arranged in the manner most convenient for storage and issue, and then an index of material location is developed. In the index the material will be arranged by symbol, and the location in the storeroom noted next to the symbol. This method necessitates designating the racks, rows, and sections in some manner that will allow the bin location to be expressed in the form of a symbol also. One method of symbolizing bin locations is illustrated in Fig. 144.

The racks are lettered, and the rows in the rack are numbered, beginning from the bottom. Finally, each row in the rack is marked off into numerical divisions which may or may not correspond with the bin arrangement. In designating bin locations, the row is used as the first digit, and the division number the last two. Thus, if the index indicated that an article could be found at D 408, this would indicate the article was in rack D, row 4, position 8. No attempt is usually made to number bins under this plan. It is particularly satisfactory if steel bins are used.

For the storage of large articles, which cannot be placed in bins, the storage floors may have each bay and section lettered or numbered in such a way that the location of articles may be recorded in much the same fashion as if they were stored in bins. Such symbols are frequently painted on supporting columns or suspended from the ceiling.

The chief disadvantage of arranging a storeroom by index rather than by classification is that the index must be consulted before an article can be found. If the stores are well controlled this is not important, for the bin location can be inserted on the stores issue at the time it is written. Another disadvantage is the fact that the men filling orders, especially when the parts handled are dirty, have difficulty in keeping the index cards clean and usable. The advantages claimed for the arrangement by index are: (1) Stores can be so arranged that those which move fastest are nearest the points of receipt and issuance. (2) No rearrangement of the storeroom is necessary as new articles to be stored are brought in or storage of certain old articles is discontinued. (3) Goods can be stored with full regard for their special requirements for storage.

Types of bins. Wherever possible, and always where large numbers of small articles are handled, racks containing bins should be placed back to back, making material accessible from aisles running between the rows and thereby economizing storage space.

Obviously, the character of the stores will determine the size and method of subdivision of the bins, but some such plan as illustrated by Fig. 143 or Fig. 144 should be adopted. Figure 143 illustrates the use of standard wooden sections. For purposes of flexibility some such unit should be devised to fit the particular conditions encountered. In this illustration, each 2-foot division can be used as a whole for the storage of materials, or it may be subdivided by inserting units or smaller bins. Thus one compartment is filled with sixteen boxes or bins known as sixteenths. The construction of these boxes is such that their outside measurements are equal, making possible the placing of sixteen of them in a division. The sixteenths would therefore be approximately 6 inches square outside. Eighths, quarters, and halves are also used. The flexibility gained through this method of bin arrangement may be readily

contrasted with the method of having all bins of equal size by reference to Fig. 145.

The amount of waste space in this illustration is obviously expensive. Figure 146 is an illustration of a well-laid-out storeroom utilizing steel bins. Although such bins are of varying size, they are rarely changed, after being set up, except by inserting or removing dividing partitions. The rows are composed of standard steel shelving.

Both the wooden bins and the steel bins which have been illustrated make for very satisfactory storage arrangements. When standard lots

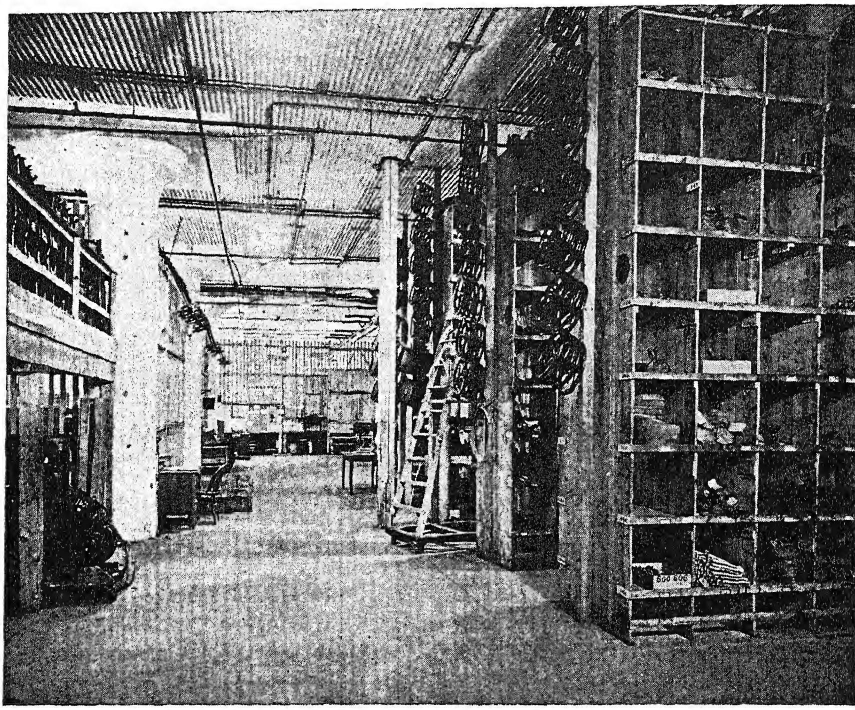


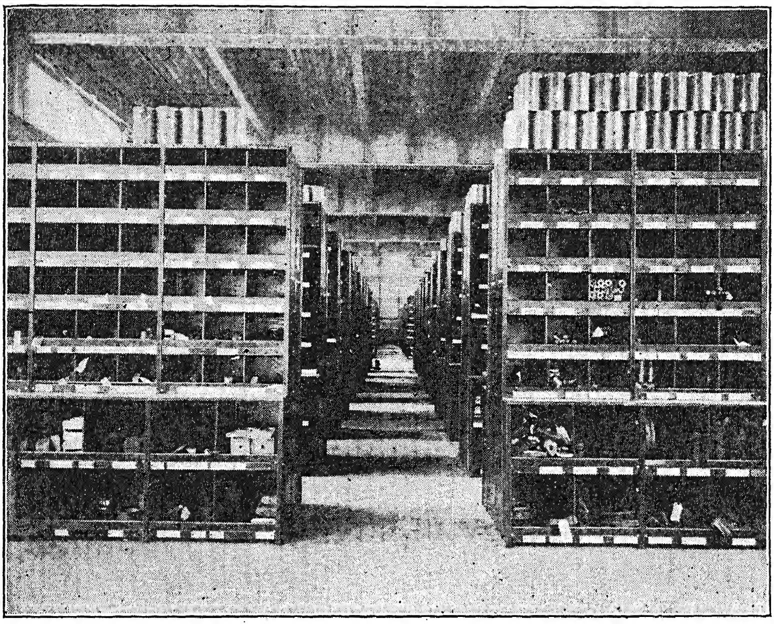
Fig. 145. Waste of Space through Inflexible Bin Arrangement.

of small materials are frequently issued, the idea of using tote-boxes as bin compartments should be considered. Steel shelving occupies less space than does wooden shelving, but it is more expensive. The original cost of the steel bins per cubic foot of storage space will ordinarily be higher than that of wooden bins. The better appearance and the sanitary and fireproof features of steel bins often cause their adoption.

Many materials cannot be stored in the type of bins illustrated, and special provision must be made for their storage. Such materials are bar stock and automobile drive shafts. Bar stock is ordinarily stored by placing it horizontally on the sides of racks shaped like an A, having

hooks on the sides to hold the stock, or by leaning the stock vertically against such A racks. Automobile drive shafts are ordinarily suspended on special racks to prevent bending. Special storage also includes storing articles in the original package.

Where there is a heavy turnover of small articles and the container is such that it fits in with the general storeroom scheme, it is sometimes advisable to store the articles in the original container. On the other hand, this practice must be carefully controlled, since it is usually cheaper to break original packages when they are received than when the storeroom men are in a hurry to make issues.



Courtesy David Lupton's Sons Co.

Fig. 146. A Storeroom Utilizing Steel Bins.

Many storerooms use the double-bin system, providing two bins for each type of material. It is evident that the double-bin system generally requires more space, but those who use it feel that this additional space is not a serious enough factor to over-balance the advantages in its favor. The double-bin system provides an "in" and an "out" bin for each article. While the material in the "out" bin is being drawn for use in the factory, newly received goods are being placed in the "in" bin. When the "out" bin is empty, withdrawals are begun from the other bin which is now tagged "out," and the empty bin becomes the receiving bin. The double-bin system prevents the accumulation of old material in

the bottom of the bin, since it is used up before the new material is used. This is of special benefit in the case of material which is likely to deteriorate. Another advantage of the system is that it gives a continuous physical check on the material to compare with the records, and this check can be made and is made each time one of the bins becomes empty. This system is successful only when the kinds of materials carried in stock are more or less constant. When the amount of material of a given kind changes considerably, or the material is only carried intermittently, the single-bin system is generally better because of the saving of floor space. The single-bin system is far more extensively used.

Auxiliary storeroom equipment. Various types of material-handling equipment have been developed particularly for storeroom use. In their nature they are similar to the material-handling equipment for general use described in Chapter X.

One of the perplexing storeroom problems where bins are used, and one that frequently prevents the use of the full height of the storeroom, is the problem of reaching the upper tiers of bins. The general practice is to use steps or ladders, but these are continually getting in the way, blocking aisles, and, in the case of ladders, causing accidents, because the worker tends to lean too far to one side rather than move the ladder. One stores manager has developed the practice of arranging the bins in such a manner that the compartments at the bottom are large enough to receive heavy or bulky material, while those higher up decrease in size as they increase in height. For instance, at the top of the first row, the depth is reduced by one board, or a foot. This forms an offset that is usable as a platform in reaching the bins above the second tier. From this the workmen have easy access to material 5 to 6 feet above, thus making it possible to reach goods to a height of 8 to 9 feet without the use of a ladder or steps. However, ladders may be necessary under certain conditions, and where such is the case, those on trolleys have usually been found to be the most satisfactory.

Storeroom personnel. Fixed responsibility is especially necessary in the storeroom. Regulations must be put into force which prohibit all but storeroom employees from entering this department or which permit them to enter only in the presence of the storekeeper or one of his assistants. Only under such conditions will it be possible to make the storekeeper solely responsible for the preservation of and correct accounting for material. The size and character of the organization for the storeroom will vary with the size and the character of the business and the character of the material to be handled. Thus it may consist of one man known as the "storekeeper," who may give all or only part of his time to the work, or it may consist of a force of men giving full time.

The statement may be heard that such conditions are applicable only

to large plants. On first thought it may appear to be poor practice for the small concern which can keep a man only partly busy on storeroom work to place one man in charge of the storeroom. Even for the small plant, however, it is advisable. For instance, it may be quite possible to assign an office employee to the storeroom for a certain length of time each day. By establishing certain hours in the morning and the afternoon this clerk can take care of all calls for material. At other hours he can attend to his regular work in the office. Some companies have met the situation by placing a workbench in the storeroom at which a worker is engaged while not devoting his time to storeroom work. A manufacturer of centrifugal machines, employing fifty men, has combined the functions of storekeeper and shipping clerk in one man.

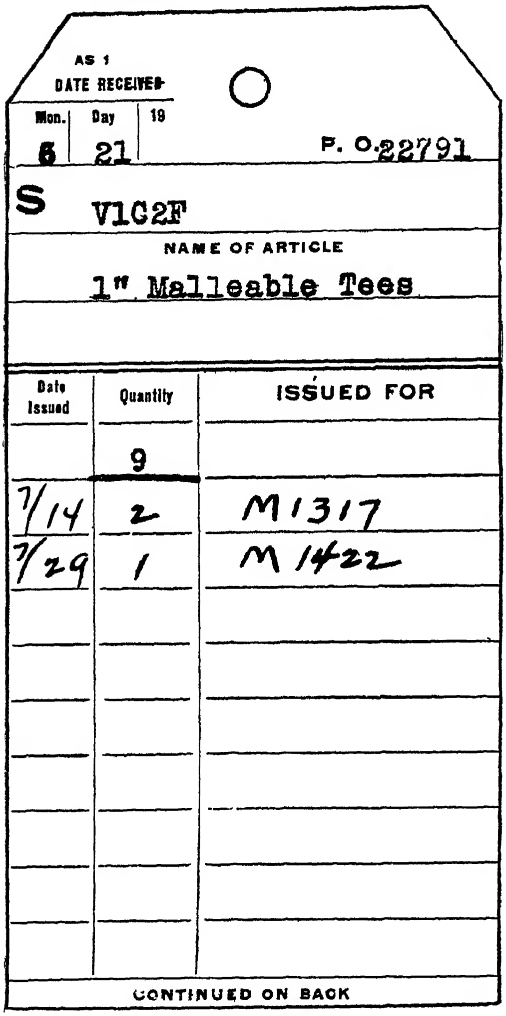
Maintenance of stores records. If balance-of-stores control be carried on elsewhere than in the storeroom, there should be a minimum of stores records maintained in the storeroom itself. The storekeeper can, nevertheless, be of great aid in carrying a share of the load of controlling inventories, if he studies conditions within the storeroom and the shops, ascertains needs, and co-operates with the purchasing department and the balance-of-stores clerk. In insuring smooth and prompt operation of storeroom routine will lie his greatest service toward good inventory control.

The storekeeper must provide a positive check that will insure that articles on hand will not fall below the designated minimum. This can be provided in some cases through the physical separation of the minimum by a partition, by placing it in a separate box, or by tying it together in a way which will call attention to the fact that some of it is being issued. Another check can be provided in the form of a bin tag on which records of receipts and issues can be maintained. If a separate bin tag be utilized for each lot received and issues deducted from the tags, sending bin tags which read zero to the balance-of-stores clerk may prove a valuable check. Figure 147 illustrates a very satisfactory form of bin tag. To be effective it must be simple, because of the usual character of storeroom labor.

Procedure for ordering material. Goods are ordered by the purchasing department, either upon their own initiative or, in procedures such as we have described, on requistion of the balance-of-stores clerk. For special materials, unclassified, requisition will usually be made directly by a department head, although the approval by the balance-of-stores clerk may be made necessary to prevent duplication of items. After receiving the requisition, the purchasing agent makes the purchase, and then sends a copy of the purchase order to the balance-of-stores clerk, which is the basis for an entry in the "ordered" column of the balance-of-stores sheet. A copy of the purchase order may be sent to the store-

keeper to serve as a basis for identifying and checking material when received. Some plants do not enter the amount ordered on the copy which goes to the storekeeper, in order that accurate count on incoming goods may be assured.

Receiving stores. All material received should be turned over to the receiving department, which may or may not be under the control of the storekeeper. If articles were delivered directly to the person for whom they were ordered, in many instances the receipt would not be recorded, which would lead to difficulty when the invoice was received. The date received, order number, weight, number of packages or bundles, charges whether prepaid or collect, and other necessary information should be recorded, so that a check can readily be made with the invoice.



AS 1

DATE RECEIVED

Mon. 6 | Day 21 | 19

P. O. 22791

S V1C2F

NAME OF ARTICLE

1" Malleable Tees

Date Issued	Quantity	ISSUED FOR
	9	
7/14	2	M 1317
7/29	1	M 1422

CONTINUED ON BACK

FIG. 147. Bin Tag.

As soon as a shipment is received the storekeeper should refer to his copy of the purchase order. He should be responsible for the count and ordering of inspection of all materials received. Theoretically, this should take place before the goods are accepted and receipted for. However, to facilitate receipts by team or truck, delivery receipts are often signed as follows: "Received subject to count, weight, and inspection. Signed ———." In this event the contents are carefully checked and inspected at a convenient time. As soon as the material has been physically checked by the receiving department, a comparison should

be made with the copy of the purchase order. Word should be sent to the purchasing department, stating the quantity of material and the general condition in which it was received. Such a report is usually termed a "Notice of Arrival," one copy of which goes to the inspection department as a notice that inspection is needed.[2] In large plants, representatives of the inspection department are part of the receiving-room staff.

Upon inspection, the inspector should fill out an inspection report, stating that all material is satisfactory or indicating rejections, with causes. One copy of this report should go to the accounting and one to the purchasing department to serve as a guide for the checking and payment of the invoice from the vendor, and for the making of claims. Where it is obvious that the material has been damaged or partly lost in transit, notice should be sent to the agent of the carrier to inspect the material. This will facilitate matters where a formal claim is to be made. Receipts of material in excess of the amounts called for on the purchase order should be tagged as "over shipment," with proper identifications, and placed to one side awaiting final disposition. A rejection tag should be placed on damaged or incorrect shipments. It is essential that descriptive data such as purchase order number, incorrect report number, kind of material, and similar information be stated on it.

When the inspection report has been received, the storeroom should make out a "Material Received" report.[3] It should preferably be made out in at least four copies and signed by the storekeeper. One copy should go to the balance-of-stores clerk who will check against the purchase order and make proper entries on the balance-of-stores sheet. One copy should be retained by the storeroom, and copies should be sent to the purchasing department and the accounting department to serve for checking invoices.

Handling materials returned from the shop. Materials returned from the shop comprise two classes, those which are returned because of necessary over-issue in the first instance and those which are returned because some change in the schedule or other complication makes desirable the prior processing of orders other than those for which the particular material was issued. With proper methods of issuing, usually only the exact quantities of material needed will leave the storeroom, but it is possible at times that over-issues must be made. The simplest

[2] In many cases the inspection department verifies the count claimed by the vendor, thus relieving the storekeeper of counting. This often is the most efficient method since it frequently prevents duplicate handling.

[3] The inspection report is sometimes substituted for this report. The inspection department in this event sends a copy of its report to the storeroom and all of the persons to whom the "Material Received" report would go.

method of handling such over-issues is to have the storekeeper attach a tag marked "surplus" to the article, and retain a copy. If the surplus amount is returned he destroys all records; but if the surplus amount is not returned from the shop, he makes out an issue slip and sends it to the balance-of-stores clerk to be properly deducted from the amount on hand and be charged to the proper accounts.

When materials are returned the storekeeper makes out a "Stores Credit" and sends this to the balance-of-stores clerk. This slip serves to credit the order to which the materials have previously been charged, and goes to the cost-accounting section for that purpose, after the proper entries have been made on the balance sheets.

Receiving worked materials. Materials on which a certain number of processes have been performed, or components waiting assembly, must be received and stored until needed. The storeroom will handle these in the same general way as material purchased from vendors, except that no inspection will be needed, and the form on which receipt will be reported will ordinarily be a "Worked Materials Received" slip, rather than a "Stores Received" slip.

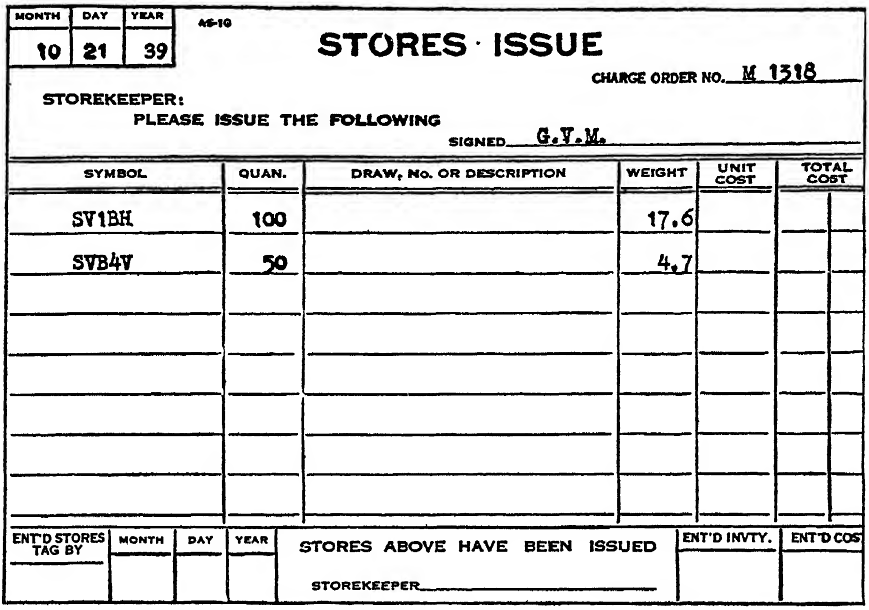
Stowing. After materials for storing have been received and inspected they may best be placed on a rack or space devoted exclusively to materials awaiting storage in the proper bins or racks. There all materials may be tagged with their symbols or bin location. Some classes of materials should also be arranged in boxes or cans in suitable units for conveyance. The articles may next be arranged on a truck, in logical fashion, in order that they may be unloaded into their respective bins with the minimum of confusion and loss of time. As the specific articles are placed in their respective bins, entries are made on the bin tag, if there be one, setting forth the date and the amount.

Issuing stores. Co-operation between the users of material in the factory, the storekeeper, and the planning department is essential in order that there may exist a definite understanding with all concerned. There should be a well-defined rule that no materials can be obtained from any storeroom, warehouse, or yard without the presentation of a formal requisition or issue ticket (Fig. 148) signed by an authorized person. It is necessary always that the storeroom receive the issue ticket from the balance-of-stores clerk in sufficient time to enable it to prepare the material for issuance to the workplace in the factory in such time that no delay will be encountered between the existing job and the new one.

For purposes of accounting and storeroom operation simplicity, some companies use two different forms for issuing purchased materials and "worked materials" produced within the plant. Other organizations use the same form for both types of materials. Figure 149 illustrates an effec-

tive stores card to be used in connection with tabulating machines. If this system be utilized, all cards may be printed in the same manner, and their various uses be designated by varying colors.

A group stores issue form is used advantageously for parts covering


MONTH 10 DAY 21 YEAR 39

A6-10

STORES · ISSUE

CHARGE ORDER NO. M 1318

STOREKEEPER:

PLEASE ISSUE THE FOLLOWING

SIGNED G.V.M.

SYMBOL	QUAN.	DRAW. No. OR DESCRIPTION	WEIGHT	UNIT COST	TOTAL COST
SV1BH	100		17.6		
SVB4V	50		4.7		

ENT'D STORES TAG BY | MONTH | DAY | YEAR | STORES ABOVE HAVE BEEN ISSUED | ENT'D INVTY. | ENT'D COST

STOREKEEPER

Fig. 148. Stores Issue.

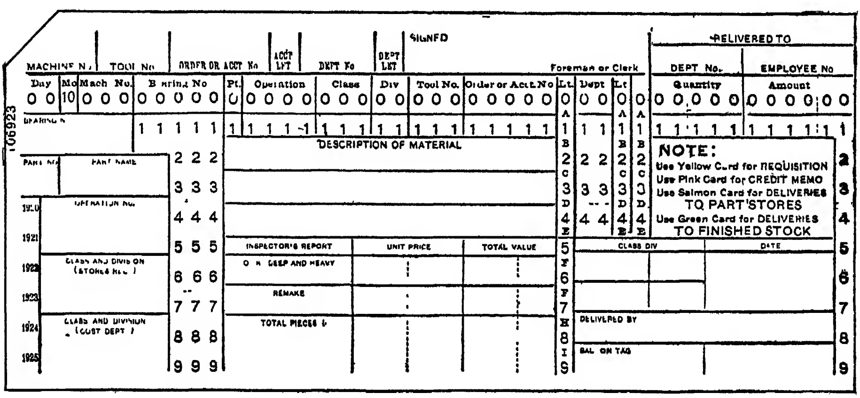


Fig. 149. Stores Card for Use in Tabulating Machine.

an entire assembly. The use of such a form materially reduces the clerical work of issuing orders. The exact details of such a form are determined largely by the individual enterprise. Such a form usually contains the same information used on the form when calling for one item

only. As a matter of fact the same form is often used either for one item or for a group of items. Some manufacturers prefer to have only one item on each stores requisition. The additional clerical work required can be justified only when special use is made of each requisition form.

In getting out the material the stores issue man should, if possible, take enough issue tickets to make up a truck load at a time. Suitable tote-boxes (see Fig. 89) may be placed on the truck to receive small materials. If the issue tickets are arranged in sequence, the issue man may move from row to row in the storeroom in as direct a line as possible. Immediately upon taking material out of a bin a deduction should be made on the bin tag, if there be one, and an identification tag, stating the material symbol order number and destination in the shop, should be fastened to the tote-box or container into which the material has been put.

The check or withdrawal slip used by depositors at banks is invaluable for accurately tracing the disposition of funds. Critics often say that such a practice in connection with the storeroom is red tape, and are eager to state that, if in order to get a screw from the storeroom, a requisition must be written out, the cost of such a procedure would be more than the value of the article to be withdrawn. It must be remembered that such a case is one fitted only for critical purposes. For practically all articles handled in the storeroom it will be well worth while to maintain a rigid control, and therefore no exception should be made for cases which will not involve more than a fraction of 1 per cent of the issuances. Office supplies and similar articles can be drawn in sufficient quantities at given intervals to overcome small issuances, a check being maintained in the office as they are issued to individuals.

Taking inventory. Although reliance on the physical inventory alone has largely passed from industry, there are still some companies that rely entirely upon it, and more which use it to supplement perpetual inventories. Its disadvantages may be summarized as follows: (1) It is taken only once or twice a year because of the cost and inconvenience involved. (2) It is usually necessary to shut down the productive processes of the plant for the period during which the inventory is being taken. (3) Accuracy is usually impossible. Speed of taking is usually the paramount consideration, and no matter how highly organized the inventorying force, there are usually a number of omissions and duplications.

The second, and now practically universal basic method of inventorying is through a book record or running inventory, such as the balance-of-stores record already described. This gives a running inventory record of every article which is kept in the storeroom. Its advantages are the

following: (1) The total inventory is found simply by taking off a trial balance of the stores ledger. (2) A record of the issuances of materials is afforded, and this may be followed up to see that the materials were actually used for the purposes for which they were withdrawn from the storeroom.

Although a perpetual inventory is provided, this does not usually mean that the taking of physical inventory can be completely dispensed with. Neither banks nor the Internal Revenue Bureau will accept unchecked book inventories, and from the standpoint of the business itself such practice would be unwise. A book inventory is never 100 per cent correct, and it is frequently far from this ideal, because of both clerical errors and unavoidable discrepancies between issues and issue tickets. In order to meet this situation there is provided some physical check of the book inventory. Such a check does not involve closing the plant to take inventory, but may be performed in one of the following ways.

One method is to check material as it reaches the minimum which has been set. The taking of physical inventory at the low limit requires little time and work. If there are bin tags, it can be done by the storekeeper on his own initiative as he notices that the balance on the bin tag has reached the minium. If there are no bin tags, the balance-of-stores clerk can make up for him a daily list of articles which his records indicate have reached the minimum, and this list can be made the basis for checking. Special provision may be made for checking items which have not reached their low limit during a period. Of course, in such cases, the maximum or ordering quantity has been set too high and should be corrected.

Another method that may be used for checking with book records is the progressive count. In the larger companies, one or two men, or as many as may be required by the particular business, may be engaged continuously in counting materials on hand. In a smaller plant the services of a clerk in his spare time each day may suffice. In either event, at given intervals of a few months, all the material is checked. Checkers start at one part of the storeroom and make the round of the department, checking all the items in a special number of bins each day, and comparing them with the balance shown on the bin tag and in the stores ledger.

A well-ordered storeroom and system of storeroom operation can be put in utter confusion by two days' use of lax methods. There will be frequently a temptation to depart from the procedure which has been set up because of a rush of incoming material, or because of a sudden need for certain material in the shop. The slight time saved for the moment in deviating from the standardized procedure will be more than overcome by the complications and losses which will ensue.

CHAPTER XLIV

CONTROL OF PRODUCTION

Control through the line organization. Under any form of organization there must be some control of the productive process. In its simplest form this control consists of taking bills of material or specifications to the shops, and giving these to the foremen to be made up into the product. Such bills of material usually originate in the office of the superintendent, and it is to him that the foremen are accustomed to look for advice in manufacture, and, roughly, for information concerning which job shall be done first. The superintendent's office, sometimes called the factory office, thus becomes the center of information regarding jobs that are to be done, and the general sequence in which they are wanted. Attention is given a particular order while in process only as pressure is applied by the sales department or by a customer who may demand prompt shipment. Pressure is then put upon this order by the factory office, whose representative may frequently be seen stalking over the production floors, looking for the order or its component parts, and brandishing the sales telegram. When the order is found, everything is pushed aside to give it precedence, the requirements for delivery on the other orders are forgotten or go unheeded, and thus the groundwork is laid for a series of similar telegrams in the near future.

In plants which are operated through the control of the factory office, it is but natural that the orders on which there is pressure are the ones that receive attention. Unfortunately, unless the customer is very patient, or the goods being made for stock are in no real demand, pressure is usually applied sooner or later to nearly every order, and in each case where there is a need for pressure there is likely to be dissatisfaction created somewhere along the line. Plants which operate their production forces in this manner happily are passing rapidly.

The simple production department. The first step toward controlling production, other than that described in the previous paragraph, usually has been taken through the creation of a simple production department, which is likely also to operate under the direct control of the superintendent. This department endeavors to decrease the number of rush

orders, so far as this is possible, by the creation of a master schedule of production, on which all orders are listed with the date of their completion specified. Orders thus take precedence on the basis of the date when they are wanted. The creation of such a schedule implies the development of a manufacturing order system, such as is not implied by the lesser control exercised through the factory office. These manufacturing orders may or may not correspond to customers' orders, but will probably be issued to the shop to cover profitable manufacturing quantities. The orders will be issued at such time that the work upon them may be completed by the schedule date, but with this exception, the time of starting work on them will usually be left to the foremen of the departments. Besides noting the date wanted on the orders, there will usually be some broad division of these into classes which take precedence one over the other. Such a division may be on some such basis as: (1) customers' orders whose promised date of delivery requires special attention to meet, (2) repair orders which were accompained by an urgent request for delivery, (3) customers' orders that would ordinarily come through on time for the promised date of delivery, (4) routine repair orders, and (5) orders for goods to be placed in stock.

The simple production department usually provides for some sort of progress report that will give daily or weekly checks of actual production against the schedule which has been set up. These progress reports give information concerning shortages of parts on various orders, and there is usually provided a force of "stock-chasers" who smooth out difficulties that may imperil the master schedule, as soon as these are seen to develop. The causes of shortages or delays may also be investigated and an attempt made to prohibit their recurrence. These stock-chasers or follow-up men may be organized on the basis of the *customer's order or related departments*. When organized on the basis of the customer's order, each "stock-chaser" follows an order or a group of orders all the way through the plant. When organized on the basis of related departments, the follow-up men will follow all orders in their respective units or departments.

This form of production control differs from no specific control more in emphasis and underlying philosophy than in details. It endeavors to anticipate delays and eliminate their occurrence while the former method strives only to correct them after they have occurred. As a matter of fact, the very first effort to control orders, other than that of rushing an order when the customer complained, emphasized largely the correcting of delays when they occurred rather than their prevention. The simple production control department basing its activities largely on releasing delivery dates and using follow-up men to see that these dates are met has taken the most important step toward complete control of

production. Since only the rough outlines of the production program are presented to the shop heads, it also must frequently act after the need for pressure has been discovered. That is, drift and check-up are still possible.

Simple production department controlling staff work. After the creation of a simple production department, ordinarily it will be found that a large share of the delays in production are due to ineffective operation of those staff functions which relate directly to production. Such functions include shop transportation, toolroom operation, maintenance of equipment, and raw materials and partly fabricated stores. It therefore frequently becomes logical to place the supervision of several of these functions in the hands of the production department, in order to correlate their activities with each other and with the necessities of the production program. Although the emphasis of the production department is still on problems relating to dates when goods are due, nevertheless its control over these staff functions is a distinct step toward the creation of shop conditions that will insure goods being produced when they are due.

The planning department. The term "planning department" is often misused by being employed as a synonym for "production department." A developed planning department is far more positive in its action than a simple production department and, on the other hand, a planning department may be only a portion of a larger production staff, the portion which does the thinking, or planning ahead. There may be other sections of the production department that aid in carrying on the developed plans of the planning section. The functions of the simple production department clearly do not include any systematic production control in advance of actual production. By far the greater proportion of its activities are of a check-up variety. That is, the department acts after it has found need for pressure at a given point in the production program. It does not act in such a manner that this need for pressure will be eliminated. It may receive information regarding progress, but it does not give detailed advance orders as to what the progress should be at all hours of the day throughout the plant.

The operation of an effective planning department entails an effective check on production needs prior to the actual times when these shall arise. The planning department's operation makes impossible a policy of drift and check-up. The performance of its functions demands such a fine balance of management that it will not succeed unless many other preliminary management steps have been taken and are making themselves felt fairly successfully.

Prerequisites of successful planning. Effective production control through scientific planning can be realized only where the background

of the organization and the current setting are right. It is far better not to undertake centralized production planning than to do so and have it fail because of inadequate preparation and sabotage from those persons who have been deprived of some of their former prerogatives. Partial production control can, as we have seen, be inaugurated with relatively little standardization of procedures, processes, materials, and product. A high degree of central control of production planning is predicated upon the existence of the following organizational policies, reliable information as to productive capacities and requirements and standard conditions:

1. Organization.

a. Management must recognize the need for production planning and be willing to delegate authority with the responsibility.

b. The supervisors whose work schedules are being centrally determined should recognize that this is merely an extension of functional specialization which makes possible their devoting more of their time to those activities for which they are best qualified. This attitude produces co-operative effort.

2. Reliable information as to requirements and productive capacities.

a. Knowledge of products required to be produced. A master schedule of production required from the sales department is highly desirable. Where production is to customer's order the schedule may be built by the planning department from the individual orders.

b. Detailed information about the number and types of each production machine and processing unit together with the feeds, speeds, productive capacities, etc. In addition to knowing the capacities it is necessary to know the available time not scheduled in the case of intermittent manufacture.

c. Detailed information as to the manufacturing time required and the sequence of operations for each part going into the finished product and the finished product as a whole.

d. Detailed information as to material requirements, amount on hand, amount required, length of time to get delivery for items purchased, quantities used per unit of production.

e. Detailed information as to the available labor in the shop and their productive capacities.

f. Complete information as to the manufacturing operations for each part, the proper tools, jigs and fixtures for same, and their availability.

3. Standardized.

a. Materials purchased and fabricated.

b. Operations on all parts as far as design permits.

c. Tools and equipment as far as practical.

d. Procedures of operations and organizational set-up, including delegation of authority and fixed responsibility.

e. Production standards for employees and method of remuneration for employees.

f. Quality requirements and adequate inspection to guarantee quality maintenance.

g. Reports on production performance in comparison with scheduled production.

The foregoing prerequisites may not all be fully realized in a particular situation but the more nearly they are realized the greater the chance for successful operation of a centrally controlled planning department.

Elements of production controlled by the planning departments. If a clear understanding be secured of the factors involved in the development of a planning department possessing the maximum of authority, it will be comparatively easy to see wherein certain phases of this authority may be denied if deemed advisable, or are unnecessary in some types of manufacturing. Therefore, a planning department which has complete control over production will be assumed. Such control implies the centralization of control over four elements of the production process. These are (1) the manufacturing orders, (2) the material for these orders, (3) the productive equipment, including machinery, tools, and workplaces to be used, and (4) the workers.

Production planning takes these four elements, works with them, each in relation to the other, and operates through them in such a manner that the product is turned out in the time and by the method that are desired. The orders are the authorization for the performance of the work, and writing them carries with it an implication of co-ordination with the sales and financial ends of the business. The material comprises everything upon which work is to be done, whether it be raw stores, worked material, or components which are the product of another plant. The productive equipment comprises all machines, tools, and workplaces within the factory which are utilized for production purposes, and its control implies its utilization for such productive work as may be deemed best at a given time. The control over workmen is from the standpoint of the man who is to be assigned to the performance of a given task in connection with a particular order. All these factors are co-ordinated by the planning department, so that a series of operations, based on needs of the manufacturing orders, upon capacities of equipment and workmen, and upon condition of material, are developed. These operations are then laid out, supervised, and correlated in such

a manner that work will proceed through the plant in the smoothest and most orderly fashion.

There is *no work performed by the well-organized planning department which should not be performed by someone under any circumstances.* (See Fig. 150). The centralization of all planning work not only insures that it be done, but that it be done by qualified persons in a way which will be of most benefit to all within the organization. The planning department provides an opportunity for the accumulation of centralized knowledge and a utilization of this knowledge.

To establish a planning department involves taking over from line members of the organization control over (1) when work is to be done, and, within limits (2) where work is to be done. The extent of control that it may exercise over these phases of the plant's activity must necessarily vary with the plant and the product. In determining when and where work is to be done, the planning department performs management functions which have been given definite technical names, the use of which will clarify any description of the work of the department and eliminate confusion of terminology. These functions are routing, scheduling, and dispatching. *Routing* includes planning where and by whom work shall be done. The *routing* work of a planning department *prescribes the path which work shall follow and the necessary sequence of operations,* particularly in building up an assembly product. This work involves such close analysis of facilities that frequently layout is affected. In quantity production plants where machines can be set up so that each performs one or several operations in direct sequence, the routing function is directly a part of plant layout. The routing section must have at its disposal all standards that have been set by job study for the operations and for shop methods. *Scheduling* involves the *planning of the amount of work* to be done and *when each element of the work shall start,* or *the order of work.* This includes planning for the quantity and rate of output of the plant or departments and also the date or order of starting of each unit of work at each station along the route prescribed. *Dispatching* involves the *meeting of schedules by proper utilization of machines, workplaces, materials, and workers, as designated by the routing.* The dispatching unit of the planning department thus includes all persons whose duty it is to see that orders are issued to the shop, that materials are at the workplace, that tools are provided, job cards issued, and, in general, that all necessary steps are taken to insure that the schedules be properly carried out.

The production department with planning as one of its divisions. In large plants the planning department is usually found as a part of a larger production organization. This structure involves no radical change in the functions or methods of operation of the planning forces.

Type	Controls								
	Rush Orders	When goods are due (including Manufacturing Order Writing, Master Schedule, Progress Reports)	Production Staff Work (e.g., shop transportation, stores)	When Orders Start	Workplace Where work is done. (Routing)	Despatching	Department where work is done and Despatching between departments	How—Job Study	Inventories
Factory Office (Line Control of Production)	X								
Simple Production Department	X	X							
Simple Production Department Controlling Staff Work	X	X	X						
Planning Department		X	?	X	X	X	X	?	X
Production Department with Planning Section		X	X	X	X	X	X	X	X
Production Department with Decentralized Planning		C	X	C	D	D	C	X	X
Production and Planning in Quantity Production		X	X	X	L	L	L	?	?

X = Function performed
C = Function performed in Central Planning Department
D = Function performed in Shop Planning Units
? = Function may be performed
L = Layout eliminates performance of function

Fig. 150. Chart Showing Functions Controlled by Various Types of Production Control.

Such an organization has been depicted already, in the illustrative organization chart discussed in Chapter VII. The staff functions of production may be entirely controlled directly by the production department,[1] or they may be controlled in part by the planning department. In the latter case such functions as factory maintenance and the establishing of standards would report to the production manager, while the balance of stores ledger control and shop transportation orders would probably be in direct charge of the planning department. The planning department exercises a functional relationship to the departments actually engaged in processing materials and may be in the position of line authority over raw materials storage and the storage of partly fabricated materials. Regardless of the actual lines of authority the planning department must work in close co-operation with the following departments: cost, purchasing, standards and methods, plant layout, tool department, factory maintenance, inspection, stores, shop transportation, finished stock, sales, and shipping. Many of the data used by the cost department are collected by the planning department. Purchases are often made on requisitions from the balance-of-stores ledger clerk. Planning is accomplished through the use of data supplied by the standards and methods department. Plant layout largely determines the routing and sequence of operations, especially in line production. Shop transportation of materials and product is usually done on order from the planning department. The availability of finished stock and the inventory of finished stock are directly tied in with the plant's schedule. Customers' orders originate with the sales department but must be scheduled by the planning department unless filled from finished stock. The sales department gets its promises for delivery dates from the planning department. The planning department relies upon the tool department for tools used in production and cannot schedule actual operations until the tools are available. The keeping of scheduled promises is intimately tied in with the maintenance of equipment in running order. Inspection in many instances is an operation in the production sequence and must be scheduled the same as other operations.

Decentralized planning control. The earlier planning departments sought for entire centralization of the various planning functions. In small concerns this is without question the desirable ideal, but in large factories decentralized control is usually found. A central department correlates the activities of the various individual planning units, which

[1] Strictly speaking, the term "production department" would include all the functions directly associated with manufacturing and reporting to the director of manufacture or works manager (Fig 9, p. 89), As used in this chapter it refers to those activities reporting to the production manager who in turn reports to the general superintendent. (See Fig. 9.)

are usually located in each of the producing departments of the plant. Under decentralized control the over-all department schedule is determined by the central planning department, but the details within the department are worked out by the individual planning unit within the department (when there is one) or by the foreman in the absence of a representative of the planning department.

The planning clerk in each department may report either directly to the foreman or to the planning department. In any case he will report to the central planning department functionally. By this system the central planning department retains essential control of production from raw materials to finished stock, and at the same time in large plants its schedules and plans become more flexible and more readily adjusted to day-by-day and hour-by-hour happenings in the shop. This type of planning control merely provides for the removal of some of the detail planning work to the departments, without in any way reducing the correlation of major activities of the plant. The central planning department still controls the schedules and the dispatching[2] between departments. The planning supervisor in each department controls dispatching within the department. Routing may be carried on in the place which seems most desirable under given plant conditions.

Decentralization of planning control brings with it relief from certain dangers which centralized control constantly must guard against. It is easy to get out of touch with departmental or plant conditions. It is easy to lose that co-operation of the foremen and sub-foremen, upon which depends, in a large measure, the success of planning work. If these men feel that orders are being sent to them for mere execution, and that the management of the plant is around them rather than through them, the planning forces are likely to lose their all-essential support. Although with central control the foremen should be in and out of the planning department all day long, decentralized control enforces the aid of foremen in planning. Thus, not only is the information collected by the experts of the planning department available, but that mass of technical information concerning production which has been accumulated by the foremen through long years of direct contact with the job can be utilized. Decentralized control should not involve supervision of clerical detail by the foreman in sufficient quantities to affect his capacity to produce. In modern mass production there is a definite trend toward decentralized planning control.

[2] Special move orders need not always be issued by the central planning department unless it is from a central partly fabricated stores, even then these orders may be quantity orders rather than orders for each load. Dispatching may be carried on by the department planning unit as soon as the work is finished in the given department. In the "flow type" of manufacture many planning details are minimized.

Factors influencing type and authority of the planning department. The extent of the authority of the planning department, be it centralized or decentralized, and the whole method of constructing its organization, must vary with the conditions of the business. These factors will govern: (1) the type of management existing, (2) the type of manufacturing in which the concern is engaged, and (3) the size of the plant. The influence of this last factor has just been noted.

All phases of management development influence the operation of production planning work. The methods of organization, the development of standards, the extent of job study, the presence or absence of an administrative budget procedure, are all important. A good illustration of the effect of the type of management on the outlines of the planning department is found in the extent of the job studies that have been made. Job study is by no means an essential prerequisite to the operation of planning control, but the minuteness with which planning may be carried on will be dependent directly on the extent of job-study data. Without job study large allowances must be made in planning work.

Planning problems in clothing and metal-cutting manufacture or in paper and standard textile manufacture are essentially similar. But the planning for production in a flour mill and in a lock factory have few similarities. In continuous industries manufacturing standard products on a quantity basis, the scope of the production or planning department is far different from what it is in the jobbing shop. This will be discussed in detail in Chapter XLIX. It is sufficient to indicate here that by giving adequate consideration to plant layout, the problems of routing and dispatching between operations have been eliminated to a great extent. It is to the schedules that most planning attention must be given in such plants.

It is in assembly industries manufacturing diverse products that the most involved planning department organization is found.

Does production planning pay? The objection that it involves large extra expenditures for clerical labor is sometimes voiced to highly developed planning work. It does involve clerical labor. That it does not involve unreturned expense is proved by the experiences of those who have installed elaborate planning departments and have had them operating for some years Clerical overhead may be increased, but shop overhead is usually decreased. It is not necessary that the small plant have a different person perform each function that has been or will be described. On the other hand, in large establishments, many workers are needed to handle the detail of planning. There is no fixed number of persons or fixed arrangement of functions possible in organizing a planning department.

Production planning is the answer to greater production on the same investment without unduly speeding up workers. One plant now has $2,000,000 less tied up in inventories than before its planning department functioned. Effective planning always means effective control of detail. It is this detail, properly co-ordinated, which makes not only for an even flow of production, but for accurate costing. This detail must be built into an effective routine without red tape.

In summary the advantages of production control may be said to include the following items:

1. Better service to customers in that promised delivery dates are kept.
2. Fewer rush orders in the plant and less overtime than in the same industry without adequate production planning control.
3. Lower inventory of work in process.
4. Less finished stock required to give the same service to customers.
5. Better control of raw material inventory which contributes to more effective purchasing.
6. More effective use of equipment.
7. Less loss of time by workers waiting for materials with improved plant morale as a by-product.

Although the development of a planning department must fit the individual needs of the particular plant, nevertheless there are certain planning ideas which can be universally applied, and it is these that will be considered in detail. In considering this detail, an assembly industry manufacturing diverse products will be described first. Since this presents the most intricate planning problems, it forms the best basis for discussion. After considering planning work for this type of industry, the necessary modifications for other types will be discussed, and will be easily visualized.

CHAPTER XLV

PRODUCTION PLANNING—ROUTING

The scope of routing. Routing is preliminary to most other production-planning steps. Including as it does *the planning of where and by whom work shall be done, the determination of the path that work shall follow, and the necessary sequence of operations,* it forms a groundwork for most of the scheduling and dispatching functions of a planning department. Only the development of the master schedule and the issuance of manufacturing orders precede it. The scope of routing may well be subdivided as follows:

1. The analysis of the finished article from the manufacturing standpoint, including the determination of components in case it is an assembly product. Such analysis must indicate the materials or parts needed, whether or not they are to be themselves manufactured for an order, or whether they are to be found in stores, either as raw or worked materials, and quantity of materials needed. Much of this work may have been done by the engineering or design department in drawing up the specifications for the product, but these must be studied and checked from the production standpoint.
2. The fixing of the sequence of completion in manufacture that one part, or piece of material, bears to another, in order that all may be brought together as needed in the process of manufacture. (See Fig. 176.)
3. The determination of the operations which must be performed at each stage of manufacture, and where these shall be performed. This implies a division into such operations as will utilize to the best advantage both the skilled and the unskilled members of the factory's production force and all equipment. It is here that the results of job studies are of great importance. The actual selection of machines and workmen after operations have been determined upon is that portion of the routing function that is most frequently performed decentrally.
4. The division of total quantities required into proper manufacturing lots or batches. This must be done with due reference to length of operations, space occupied by the material while moving through the shop, and the requirements of the master schedule.[1]

[1] See Fig. 176, p. 615 for a combination schedule and route chart.

It is the performance of the routing function which perhaps most clearly distinguishes the work of the planning department from that of the simple production department. It must be evident that practically all the work of routing concerns production control in advance of actual production. The automobile is a product in the manufacture of which the various phases of production control, routing, scheduling, and dispatching, have been highly developed. The finished car is essentially an assembly of various parts that have been manufactured and brought together as sub-assemblies. Similarly, in manufacturing an assembly product, such as a lock, there are a number of small components, each of which must be provided in adequate amount prior to any attempt to make either sub-assemblies or the finished product. The raw material comprising each of these components must be put through a number of manufacturing operations prior to being available for sub-assemblies, and decision must be made concerning the most economical operations and machines for the manufacture of each component with due consideration to other current demands on the workmen and equipment of the shop. Since a padlock is a product which is of common usage and whose components are fairly well known and since its manufacture clearly demonstrates the need of routing and planning work in general, it will be used largely as the basis for illustration.

There is some manufacturing in which the work performed in the plant is so extremely simple, and the product is so uniform, as to require only a very simple routing mechanism, if any, after the plant once begins operations. For instance, a flour mill which operates day after day and year after year on the same kind of raw material, turning it into the same type of finished product, would have but little need for an elaborate system of routing. However, even with standard product, there are usually several types manufactured; some components or materials take longer to work up than others, and thus numerous problems of routing and machine utilization arise.

Interrelation of routing, classification, and layout. In its application, routing is closely bound up with two management steps previously discussed, classification and layout. Figure 27,[2] Chapter IX, portrays vividly the importance of layout in automobile manufacturing. The plant layout determines to a large extent the route a given part, sub-assembly, or product will take. As was previously pointed out, line production or layout by product greatly simplifies production control. One of the outstanding trends during the past ten years in manufacturing and production planning control has been the increased use of layout by product which facilitates inventory and production control. This type of production control is known as "flow control." The essential features

[2] See p. 134

of this type of production control is starting the product on a line and having all needed parts available as the assembly proceeds. Figure 176 illustrates a series of interrelated line controls.

The second management step closely associated with routing is classification of materials and operations. Routing and classification should be interdependent. A skeleton classification for stores, worked materials, and finished stock is of great assistance in developing routing work. And, as the route of a product is determined, components are analyzed, and the operations fixed, the subdivisions of a classification develop and may be recorded on the classification sheets. Ease of routing will be greatly enhanced if material symbols and operation symbols are so devised that they may be used directly in the work of routing and included in the routing instructions which are issued by the planning department.

Use of bills of material in routing. Routing work in a planning department begins with the receipt of a manufacturing order from the proper authority. It must necessarily be based upon the bill of material or specifications which are received from the engineering or design department. As indicated in the accompanying illustration (Fig. 151) of a section of the specifications for a padlock (see Fig. 182, p. 639), this will usually give a list of the components of the product, together with specifications of the material from which they are to be made, manufacturing tolerances in case of machined parts, and frequently a list of the operations to be performed on each component. This last item may be left entirely to the production forces; but if it is, close contact must be maintained between the two departments to insure that designs do not involve unnecessary manufacturing complications.

Not only must complete specifications for the finished material be on hand before routing is attempted, but there must be much additional information available. On operations which have been previously performed, job-study data should be available for reference, and on new operations job studies must be made and the results reported back to the planning department. If there be not time for job studies on new operations, then the advice of the job-study man or the foreman must be secured concerning the routing of the work. He will be able to give much valuable advice from his knowledge of equipment capacities. It must not be inferred that the route man may be ignorant of the shop equipment. If routing is to succeed, the route man should be the person in the whole shop organization who knows most concerning manufacturing method.

If routing to particular machines is to be attempted, some record of available machine capacities must be at hand. This may take the form of a rough record of the relative amount of work that is being

Part	Number Required	Kind of Material	Size of Material	Gross Weight of 100-Pec Lb.	Operation
DOG.	1	Drawing steel	075 × $2\frac{1}{16}$ × C plus and minus .002	1 9148	Pierce and blank Sort Form 1st operation Light rumble in sand Form 2nd operation Rumble in sawdust Countersink dog tube hole Caseharden (done outside) Copper plate Brass plate Rivet dog tube Deliver to FS.
CASE STUDS	5	F. M. Yellow Brass Rod	.187D × 11′ plus and minus .001	7286	Form and cut off Whiz Rumble in sawdust Deliver to PS
BOLT SPRING POST	1	F. M. Yellow Brass Rod	187D × 11′ plus and minus 001	.5283	Form and cut off Whiz Rumble in sawdust Deliver to PS
SHACKLE SPRING POST	1	F. M Yellow Brass Rod	.125D × 11′ plus and minus 001	2442	Form and cut off Whiz Rumble in sawdust Deliver to PS.
DOG STUD.	1	F M. Yellow Brass Rod	.156D × 11′ plus and minus .001	.4759	Form and cut off Whiz Rumble in sawdust Deliver to PS.

FIG. 151.—Section of Specification Sheet or Bill of Material

given to each machine, or it may take the form of the more complicated machine load as portrayed by the Gantt chart.[3] Such a record will prevent preference always being indicated for some particular machine or machines if alternate choices can be made, and will enforce consideration of the utilization of all of the equipment of the shop on those in charge of routing This record quickly indicates the approximate amount of work that the routing has at any time assigned to each machine or class of machine in the shop. In order to promote flexibility of dispatching, alternate machines should be indicated in the routing whenever possible, but where there is a cost advantage in the use of one machine over another, this should be shown by designating clearly the preferred machine. Frequently, because of the nature of the operation, no preference can be shown.

Preparation of the route sheets. From the data at hand the route sheets and material for the route file are prepared. Route charts may also be prepared, as will be illustrated. Route sheets, as will be noted from the accompanying illustrations (Figs. 152 and 153), list fully the materials that are necessary for a given operation, the complete list of operations in sequence, and the machines on which these are to be performed. In addition, for dispatching purposes, the standard time for each operation may be given, and check spaces are provided to record the progress of the order through the shop.[4] Diffierent types of route sheets are usually needed for components and for assemblies, because of the different natures of the operations involved.

Route sheets serve two purposes: (1) They indicate, for scheduling and dispatching purposes, the necessary operations to be performed, and the place where they are to be performed. (2) Through the check columns, they provide a progress report which will give at any time the status of any component, assembly, or order that is in manufacture. Furthermore, since only one lot of material is governed by a single route sheet, the work is divided up definitely into the proper lots or batches which have been determined upon as desirable from a manufacturing standpoint.[5]

So-called "master departmental or divisional route sheets" are frequently made out in the central planning office and given to the decentralized planning office as a guide to this officer. This route sheet would

[3] See Fig. 157, p 585.

[4] It should be clearly borne in mind that these forms are purely illustrative. Each industry's needs and the requirements of each department will govern the exact form and data to be included. Production control systems, like other management techniques, should be adjusted to the needs of the individual enterprise.

[5] This statement, of course, implies that there is sufficient volume to justify the desired economic lot size.

show the sequence of operations and desired machines, but not the exact machine unless there is only one machine of the desired type. Assembly route sheets must show clearly the sequence of assembly operations,

SYMBOL P2½ H1B DRAWING NO 50936 DATE 4/7/39 WRITTEN BY F.E.W.

DESCRIPTION Back, 2½" Heavy Duty Padlock

QUANTITY IN LOT 20,000 MATERIAL SV .083 × 2 15/16 SCR

TIME PER PIECE, HRS.	PREP HOURS	OPERATION NUMBER	OPERATION DESCRIPTION	MACHINE NO.	MOVE	OPERATION	FIRST INSP	FINAL INSP
			Material Apportioned and On Hand					
		1	Blank & Pile (Together with P2½ H5M)	PA 17				
		2	Form & Stamp	PD 7				
			To Process Stores					
		3	Pierce	PD 9				
		4	Straddle Mill Shackleway	MP 5				
		5	Rumble in Sawdust	T 2				
		6	Grind burrs on top	G 7				
		7	Punch Shackleway Heel	PH 4				
		8	Punch Shackleway Nose	PH 5				
		9	Planish Shackleway	PD 22				
		10	Trim	G 4				
			To Process Stores					
		11	Rumble in Sawdust	T 2				
		12	Sand blast	X 8				
		13	Ebony Black Rustless Finish	X 11				
			To W. M. Stores					

Fig. 152. A Route Sheet for a Component.

particularly whether the operation may be performed independently or simultaneously, or must be performed in sequence after another assembly operation, because it depends on the product of the latter for a portion of its material. To illustrate, in the assembly of a padlock (Fig. 153),

SYMBOL P2½ HB DRAWING NO. 50935 DATE 4/7/39 WRITTEN BY F.E.W.

DESCRIPTION Back Assembly, 2½" Heavy Duty Padlock QUANTITY IN LOT 20,000

TIME FOR OPERATION	DRAWING NUMBER	CHECK: INDEPENDENT ASSEMBLY	CHECK: SUCCESSIVE ASSEMBLY	ASSEMBLY OPERATION: NUMBER	ASSEMBLY OPERATION: DESCRIPTION	LOCATION	MOVE	OPERATION	FIRST INSP	FINAL INSP	STORES AND WORKED MATERIALS NEEDED FOR EACH OPERATION: QUANTITY	O.K.	DESCRIPTION
		✓		1	Rivet Case Studs & bolt spring post	R 1					1		P2½ H1B
											5		P2½ H2B
											1		P2½ H3B
			✓	2	Rivet Shackle Post	R 3					1		P2½ H4B
			✓	3	Rivet Dog Stud	R 4					1		P2½ H5B
			✓	4	Rivet Shackle Spring Post	R 5					1		P2½ H6B
					To W. M. Stores								

Fig. 153. An Assembly Route Sheet.

the assembly of the back is composed of one independent and three successive operations. On an assembly route sheet it is necessary to show what additional material is needed for the performance of each operation, as may be added at various points in the assembly process.

Combination routing. Because of particular manufacturing conditions, it may be desirable to have two batches of material routed together for a certain distance through the course of manufacture, and then split. Or it may be desirable to bring together two or more batches of material at given points in the manufacturing process, although in the main they will follow separate courses. Such conditions usually call for combination routing, which provides for the routing of the various batches so that their relation one with the other will be clearly evident. Combination routing is provided for several jobs in production, which may use the same set-up on any machine. In order to save time and set-up cost, these jobs will be routed in combination.

Preparation of tickets for dispatching. A portion of the routing function usually includes the preparation of the route file, which includes all tickets needed for planning and dispatching work during the course of the order in the shop, such as time and job tickets, issues for worked materials and stores, operation orders, inspection tickets, and move tickets or tags. These tickets, which are usually written in the main by some duplicating process, are suitably taken care of by some filing scheme until they are needed for dispatching. Sometimes they are all placed in pockets in a specially constructed file, which will contain all route sheets and papers pertaining to one manufacturing order. Thus the route file will contain information concerning the path that that order is to take through production, plus all necessary forms which will be utilized in dispatching, working, paying for labor on, or recording costs, for the order plus the necessary columns on the route sheet to record accurately the progress of the order. To these often will be added tool lists to be sent to the tool room as given operations are called for in the process of dispatching, and instruction cards to be issued to the workmen as the operations are to be performed. Route sheets are at times arranged in the form of a visible index, so that they may be easily referred to by the dispatcher, in which case the necessary forms are filed close by in boxes or tub desks (Fig. 154). The use and issuance of the various papers which are prepared will be described under the order of work and dispatching procedure (Chapter XLVII).

Special equipment has been developed to be used in connection with the modern tabulating machinery which greatly modifies and simplifies the preparation of all the orders and instructions used in production planning and control. Master route cards, instruction sheets, etc. are prepared and filed for future use.[6] From these master forms additional

[6] See *Factory Management and Maintenance*, Vol. 95, No. 9, September, 1937, pp. 69-80, "Factory Orders and Inventory Records," by Kenneth Porteous, for a description of the system used by the Union Switch and Signal Company, Swissvale, Pa.

cards may be duplicated as to both punched coded holes and typing. These cards are released to the factory and when returned, provide data in detail for payroll, cost-determination, material-control, production-control for later jobs, etc. Where the volume of production justifies the installation, this method of production control, cost collection, and payroll computation offers real economies. It is particularly valuable in cost-determination for parts, sub-assemblies, and the finished product.

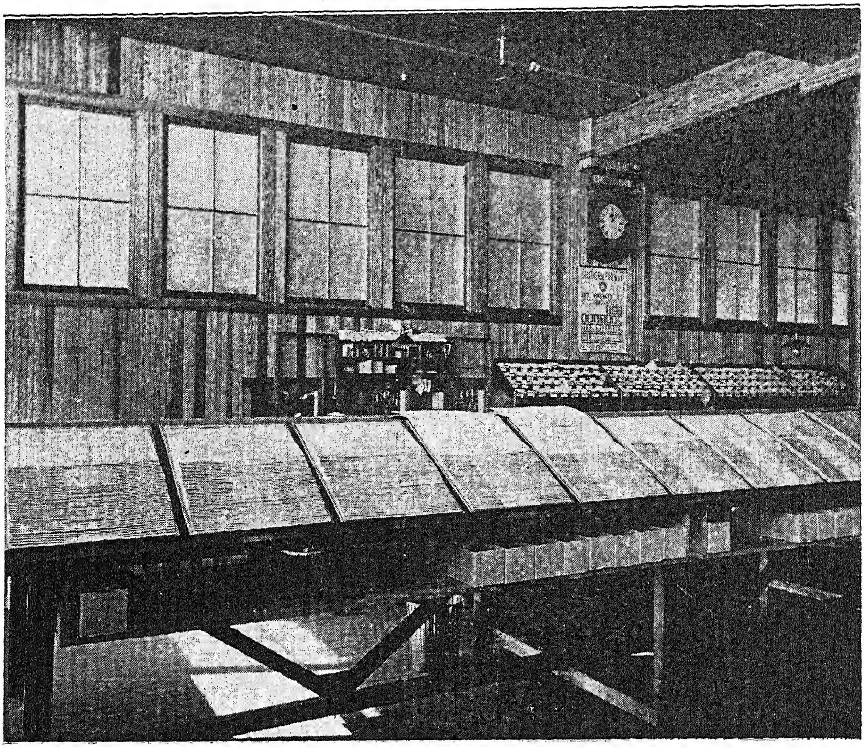


Fig. 154. Route Sheets (in foreground) and Machine Boxes (in rear, along wall), Universal Winding Co., Providence, R. I. (Note the boxes containing dispatching forms, located below the route sheets.)

Much of the duplicating of orders and forms is performed by mechanical means after the initial master card is made.

Close interrelation of routing and scheduling. Although routing presumes the best possible utilization of equipment, still it is desirable in routing work to observe closely the conditions of the plant schedules, and not leave too much leeway in the selection of equipment and too much of the adjustment function to dispatching, which is largely a routine, clerical job when routing has been carefully and adequately performed. In routing, an attempt is always made to prevent the utilization of a

large, expensive machine for a small job that can be done on a small machine, and yet if the schedule of work is not providing operations for the large machine, and is overcrowding the small one, the route man must take this into account in designating the path that material shall follow. Although he desires always to use the machine that is best fitted for a particular operation, still there is ordinarily no object in having machines idle while others have jobs waiting.

Use of route charts. Standard route charts, which set forth graphically, in definite order, the operations, materials, machinery, and grades of labor required to make a finished product in the most economical manner, are utilized frequently (Fig. 155). They serve as a permanent record, and as a guide in drawing up route sheets for individual orders. They are most practicable with standard repetitive product, but can be used profitably in any plant where the sequence of operations is similar, although particular operations may vary. On such charts the operations are so set forth that their sequence is made perfectly clear, and, in the case of assembled products, that the sequence of assembly of the various parts is carefully shown[7] All independent groups of the finished product are so separated that those operations which may be performed independently may be seen at a glance. Generally the following information is included: materials needed, with symbols; operations, with numbers; and best machines or equipment for their performance. At times alternate machines are designated upon the chart, in which case the estimated relative costs of performing the operation, on the alternate machines may well be included in order to eliminate the tendency to utilize the most costly machine. The original of the attached chart was a blueprint, as is usual. Hence the black squares in the illustration were white spaces in the blueprint. These spaces allow for the writing in of operation numbers, lot numbers, etc.

Combination schedule and route charts provide for the charting of all operations and assemblies in proper sequence upon a scale, which is so computed toward the left from final assembly that reference to the chart will indicate exactly when any component must be placed in production.[8] This chart is so devised that the necessary operations upon components and the sub-assemblies into which they go may be performed in time to have them meet with other components for semi-final or final assembly on schedule. Such a chart is extremely valuable if shop conditions permit a smooth flow of work. Sufficient time must be allowed

[7] See Ralph Currier Davis, *Industrial Organization and Management*, Harper and Bros.. New York, 1939, Chapters 12, 13, 14, and 15, for an interesting discussion of production control. See especially p 274 for a "manufacturing assembly diagram."

[8] L P Alford, *Cost and Production Handbook*, The Ronald Press Company, New York, 1937, pp. 245-257, 260.

between operations, in laying out such a chart, for goods to be inspected, and moved. This time is usually arbitrary and is the same for all operations and departments. It must be so regulated that orders will move at the greatest possible speed, to prevent unduly large inventories of material in process, but nevertheless so that there will be a factor of safety remaining. Many production control boards have been worked out on this principle, and are in reality only enlarged charts in board form.

CHAPTER XLVI

PRODUCTION PLANNING—SCHEDULING

Scheduling production provides for the setting of beginning and completion dates for each manufacturing order or portion of a manufacturing schedule, and for the determination and rearrangement of the order of work within the shop so that the completion dates may be met. The most familiar form of schedule control is that of the railroads. The processes of industrial scheduling are essentially similar. Predetermined schedules control the operations of the offices of railroad dispatchers. Similar schedules control the dispatchers of industrial production. Factory scheduling involves essentially the same elements. There are regularly scheduled orders to be taken care of, each of varying importance. Then there are special orders and special conditions to be met, as shop conditions change or as the regular schedule is interrupted. The equipment of the factory is almost as limiting to the passage of orders, one around the other, as are the rails of the railroad. And orders must be scheduled and schedules must be changed to meet conditions, if the demands of production and the requirements of sales are to be met. That is the function of scheduling.

Professor Henry P. Dutton has said:

> Before an intelligent plan can be made for the production of an order, at least the following steps must have been taken:
>
> *a.* The translation of the order into terms of shop requirements. This involves editing the order into terms of shop pattern numbers, symbols and so on, also the preparation of parts lists and process analyses.
>
> *b.* The matching of requirements for materials, machine capacity and other elements against the shop capacity. This involves first, the check of parts lists against stock records and second, the setting aside of the required hours of productive capacity, after consideration of the reservations already made for other orders. Consideration of this stage may involve increases of permanent capacity, when warranted.
>
> *c.* Scheduling as shown above described, depends upon the securing or possession of knowledge of machine capacities and rates of output and is limited in its precision by the ability to maintain accurately the predicted rates of output.[1]

[1] Henry P. Dutton, *Trends in Production Control*, an address delivered before the Annual Convention of the Society for the Advancement of Management in New York, October 5, 1939.

The first of the foregoing steps is essentially a clerical step following prescribed patterns and procedures. The second step is concerned primarily with scheduling. The third requirement lists the foundation upon which scheduling rests. There are two distinct phases of production scheduling. The first is a carefully drawn master schedule which indicates the relative importance of manufacturing orders. This may be developed prior to or coincidently with routing. The second is the determination of the order of work, or the exact order of operations of each portion of each order that is performed at a separate workplace. This phase of scheduling follows routing in performance, and is carried on either prior to or coincidently with dispatching. The *determination of the order of work is primarily a dispatching function.* Inasmuch as they are frequently carried on coincidently, it is difficult entirely to separate the two in a discussion. However, in so far as they may be separated, the understanding of the planning function in its elements, rather than in a particular installation, will be clarified.

Master schedules of production. In scheduling production, manufacturing orders originating from direct customers' orders, or as a part of manufacturing budgets, must be so arranged that the plant may be operated at its maximum manufacturing effectiveness. If possible, each productive unit should be so provided with work as to allow it to be operated continuously. But, primarily, sales requirements must be met. The work of scheduling comes into more direct contact with the sales department of the business than does that of the other planning functions. General policies regarding the relationships of sales and production are determined by the general management, by budget meetings, or by the daily contacts of the production manager and the sales management. In large plants, the production manager may deal more with broad policies than with specific sales orders. In such cases the arrangement of the production schedule may be entirely a function of whoever is in direct charge of scheduling production. Manifestly, in small plants, the production manager will himself directly control scheduling.

In the development of a master schedule, it is essential that there be careful co-operation with the sales department, not only that information concerning sales needs from the delivery standpoint may be considered, but also that information concerning prospective orders may be secured.

It is no exaggeration to say that the sales department, when operating within the prescribed company policies, provides the data or raw material from which the master schedule is built. When a company is operating on a complete budgetary basis the master schedule is an extension of the budget. Since the annual or quarterly budget cannot give details of customers' orders as yet not received, it is particularly necessary that close co-operation exist between the scheduling division of the planning

department and the sales department in cases in which a plant manufactures both to customers' orders and to stock. This indicates that if the production manager does not directly control scheduling, the one who does must sit, along with the production manager, on such committees as deal with the co-ordination of efforts of the sales and production departments.

Issuance of manufacturing orders. Manufacturing orders, based on the master schedule, will usually be issued as a part of scheduling work. These orders may be subject to subdivision into economical manufacturing batches by the one in charge of routing; nevertheless, they will usually be issued with full consideration of this factor. A single manufacturing order may cover only a portion of the manufacturing budget for a particular article, or it may combine two or more customers' orders for the same article.[2] Thus small customers' orders or large stock orders are increased or subdivided into profitable manufacturing quantities. The shop does not care who gets the finished product. It does want to know how much is wanted and when it is needed. This usually is stated on the manufacturing order, and the due date which is placed upon it corresponds to the sequence of the master schedule. An effective manufacturing order blank is illustrated in Fig 156. It is thus clear that the master schedule must be so arranged as to indicate (1) the due date of all orders, (2) groupings of orders into broad classifications of importance, and (3) subdivisions of groups in accordance with particular circumstance, such as the time required to manufacture.

Master schedules—plants manufacturing to customer's order. There is no hypothetical grouping of classes of orders that will be fully satisfactory in any and all plants. Nevertheless, those in charge of scheduling must be governed by the same general considerations, regardless of the plant. In plants manufacturing primarily to customer's order, these orders will be seen to subdivide themselves into some such general classes as the following: rush, regular, repair, and stock. Any order falling into one or the other of these classes will, in general, be given precedence in accordance with the class in which it falls, in the order just enumerated.

[2] Some manufacturers, particularly in the clothing industry, release production to the processing departments in quantities measured in terms of the producing capacity of the departments on a time basis such as one hour. These releases are known as "blocks" and may be made up of several customers' orders combined to give the hour's work, or it may be only a part of one customer's order, depending of course on the size of the orders. Other manufacturers in mass production release orders in terms of lots which may cover a part of a day's run or several weeks' run of the same part or product. All labor and material that can be allocated to the lot is charged to the particular lot number. This system ties in well with the cost control program. Materials' releases and schedules are in terms of the lot.

Rush orders include those which are received with necessary delivery dates so stipulated as to make these prior to the time at which the product would naturally be completed in the ordinary course of production. Whatever the desires of executives, this class of orders seemingly never can be completely eradicated. Rush orders also come to include those on which there has been a tie-up somewhere in the production process, which has thrown the individual order back of its previously determined schedule particularly in cases where delivery promises have been made contingent upon adherence to that schedule in the manufacturing process.

L. M Co SF 48 A AP G, A.G. Co 9162 **PUT-UP MANUFACTURING ORDER**

PLEASE FINISH THE FOLLOWING:	ORDER ISSUED			ORDER WANTED			ORDER DUE			ORDER FINISHED		
	MONTH	DAY	YEAR	MONTH	DAY	YEAR	MONTH	DAY	YEAR	MONTH	DAY	YEAR
			19			19			19			19

QUANTITY IN LOT	KIND OF UNIT	GRADE	SYMBOL	DESCRIPTION

REMARKS· ____________________

SIGNED____________________

MANUF'G ORDERS for which these goods are needed	MANUF G ORDERS for which this order is waiting	QUANTITY FINISHED				SHIPPING ORDERS awaiting completion of this order	TICKLER DATES					
		Firsts	Seconds	G E.	Date		MONTH	DAY	MONTH	DAY	MONTH	DAY

ORDER WRITTEN		ROUTING LAID OUT		BILL OF MATERIALS PREPARED		MATERIALS APPORT'D AND REQ WRITTEN		MACHINE RECORD		PROMISED DATE DETERMINED		ROUTE FILE PREPARED		COST SHEET WRITTEN		MATERIAL DELIVERED AND WORK STARTED		WORK FINISHED		BALANCE CARDS		MACHINE RECORD		COST PREPARED	
DAY	HOUR	DAY	HOUR	DAY	HOUR	DAY	HOUR	DAY	HOUR	DAY	HOUR	DAY	HOUR	DAY	HOUR	DAY	HOUR	DAY	HOUR	DAY	HOUR	DAY	HOUR	DAY	HOUR

FIG. 156 Manufacturing Order, Lewis Mfg Co., Walpole, Mass.

By *regular orders* are meant customers' orders which are received with delivery dates specified that fit into the usual requirements of factory production. Such orders ordinarily take precedence over repair orders on goods already sold, although there may be circumstances when these latter will come even into the rush class. If there are many repair orders, they may be put through on an entirely different manufacturing basis, and, in large plants, in different departments from regular orders.

Master schedule—plants manufacturing for stock. In a factory that manufactures a variety of standard products for stock, from which customers' orders are filled as they come along, there is usually developed a production budget or "demand estimate procedure." This carefully

drawn estimate of production needs, such as has already been discussed, serves as the basis for the development of the master schedule. If a plant be on such a manufacturing basis, it has achieved a flexibility of scheduling such as is not possessed by the factory which operates primarily to customers' orders.

The manufacture of materials for stock implies even a closer liaison with the sales department than does the production of orders directly to fill customer's demand. It also implies a closer relationship with the policy control of the company, since, in order to schedule product which has not yet been sold, it is necessary to have a definite knowledge of future company sales and production policy, as well as a knowledge of the financial affairs of the plant. It is not to be assumed that those in charge of the preparation of the master schedule will have all of this knowledge. They will, however, be governed by their demand-estimate procedure, which will have been so worked up as to include this detailed knowledge of company policy whether or not there be a general budget.

Companies which wish to avoid production tie-ups, and which operate on the basis of manufacturing to stock, usually have their schedules developed months in advance. Unless there is some arrangement made whereby these schedules may be readily changed, it is very likely that financial difficulties may be encountered because of the working capital which is tied up in material. The close liaison necessary between the scheduling function and the balance of stores function must be evident.[3] There must be continual conference between those in charge of these two phases of control.

In manufacturing to stock, customers' orders are usually regarded as special and not allowed to interfere with the regular schedule. However, the rush order still persists. It is probably clear that the necessity frequently arises, during the progress of an order through a shop, to change it from one status to another, thereby changing the precedence accorded it.

The master schedule should not be looked upon as something rigid into which a new order finds a definite place upon its receipt in the shop, that place never to be changed. On the contrary, it should be regarded as a continually flexible piece of shop mechanism, which is changed week by week, perhaps day by day, as conditions change with the receipt of new orders, the completion of old ones, or the development of some new condition in the shop.

Master schedule based on standard hourly production. If job studies or analyses of machine capacities have been made in detail, data can be

[3] Because of the close cooperation necessary between the balance-of-stores-ledger clerk and the scheduling clerk, it is quite common to find both in the production control planning department.

worked out which will give the standard hourly production for a given machine or a given department, or on a given operation. These data may be used to set up a master schedule. If the product be standard it may be desirable to set up a schedule board that will give in detail the time of starting and stopping of each major operation on each part which goes into the product. It is wise to set up such a board on the basis of some thing less than 100 per cent efficiency. Progress reports which come from the production departments may then be checked with the master schedule that has been set up, and the order of work changed to rectify any undesirable conditions.

On unstandardized, diversified product, the master schedule may be set up in terms of hours of work ahead on given classes of products. Such information, which may be termed the balance of work ahead, can be easily communicated to the sales department. Machine tabulation control methods described in the previous chapter are particularly well adapted to provide the number of hours of work ahead of machines. In making sales, the sales department can deduct the time required for their manufacture from the balance and thus can always know the unfilled capacity of the plant which it may sell. Such a program involves determining everything in terms of hours of time it takes to produce the product, by departments. The sales department must be kept constantly informed concerning this. In a sense the sales department sells departmental time rather than products, and the scheduling work is concerned with time rather than with products.

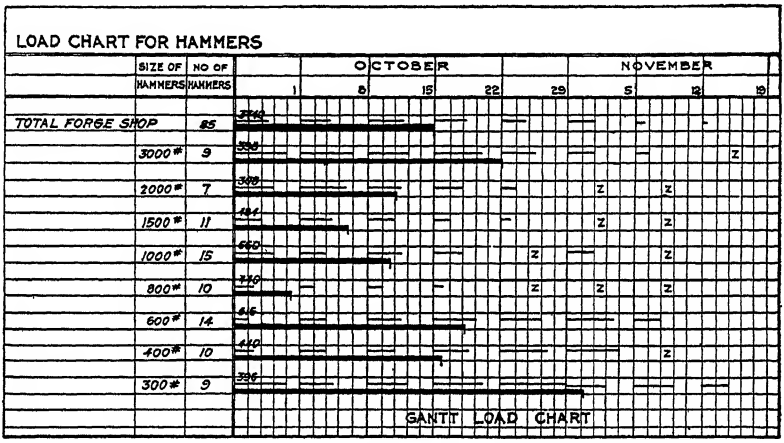
The load chart. The creation of a schedule based on standard hourly production, and the ability of a sales department to keep manufacturing departments constantly supplied with orders, is greatly enhanced through the use of Gantt Load Charts, similar to the illustration (Fig. 157). This chart was prepared by Mr. Wallace Clark and is reprinted by permission from his book, "The Gantt Chart."[4] It illustrates the scheduled load of a forge shop. The first line of the chart indicates the total work ahead of the shop, by weeks and as a grand total. The other lines indicate the amount of work scheduled ahead for each class of hammers, by weeks and in total. The figures 396, 308, etc., indicate the weekly capacity of each group of hammers, based on a 44-hour week. Thus the chart indicates that the 3000-pound hammers have enough work scheduled for them the first week to keep them busy 80 per cent of the time, as indicated by the light line, whereas for the week ending November 5 only 40 per cent of their capacity has been booked, and zero has been booked for the week ending November 19. In general, if material and tools were available, these hammers could continue steadily for four weeks

[4] Wallace Clark, *The Gantt Chart,* The Ronald Press Company, New York, 1922, pp. 77-80.

on orders already booked. The shop as a whole had 50 per cent of its capacity booked for the first week and a total of three weeks' work ahead.

Another method of keeping a record of the hours scheduled ahead of a machine is a simple card type of ledger for each machine or group of similar machines in a work center.[5] It is somewhat simpler than the Gantt chart and is well adapted to a small enterprise.

Master schedules in quantity production plants. In quantity production plants, as indicated in Chapter XLIX, the master schedule merely consists of a statement of the number of units of production to be produced in a given month, week, or other production period.



Courtesy, Wallace Clark and The Ronald Press.

FIG. 157. Load Chart for a Drop Forge Department.

The order of work. The preparation of the order of work differs from the development of the master schedule, inasmuch as it concerns itself with detailed operations of manufacture of a product, rather than with the completed product. The control exercised by the master schedule throws emphasis on bringing the final delivery date to such a point as to coincide with the needs of the sales department. The development of the order of work should control the step-by-step progress of the work through the factory in such a way as to bring the finished product through the process of manufacture at such a time as to meet the needs which have been set down by the master schedule. *Changes are but infrequently made in the master schedule as compared to changes in the order of work.* The latter feels the ebb and flow of factory conditions.

[5] See L. P. Alford, *Cost and Production Handbook,* The Ronald Press Company, New York, 1937, p. 254.

A particular machine may be broken down, a particular workman may be out, and these may change the order of work on another machine or for another workman, in order that the needs of the master schedule may be met. On the other hand, such small recurring factors do not in any way affect the master schedule.

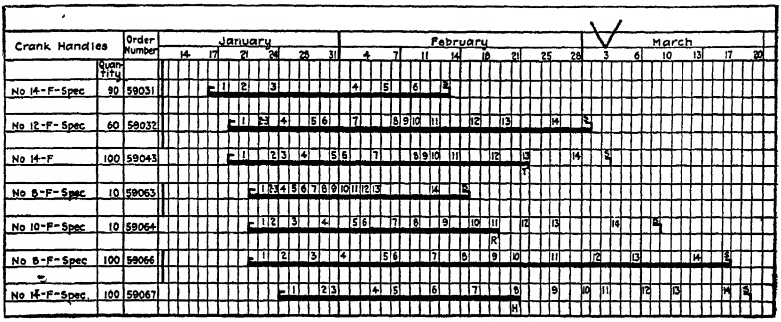
In the development of the master schedule, the orders must necessarily be arranged in accordance with their relative importance. In arranging the order of work, the operations must be arranged in such a way as to consider the amount of work which must be done on each and the conditions which exist in the shop, as well as the date when the final work on each order must be completed.

Progress charts as an aid in scheduling. The method by which the scheduling division receives the information on which to base changes in its order of work is through the creation of a system of progress reports or progress charts. These give up-to-the-minute information concerning the progress which has been made on various orders that have been started through the process of production and which, therefore, have already been given a place in the order of work. If progress charts indicate that any order or any part of an order is falling behind the schedule, steps are immediately taken to advance this order or section of an order to a higher position in the order of work. Posting to charts is often made at the completion of each operation. The frequency of these postings is determined largely by the closeness of control desired. It is not unusual after a system of production planning control has been in successful operation for some time to discover that posting once a day or at some other longer interval is adequate. This is true especially when producing for stock.

The Gantt progress charts. The most effective type of progress chart is the Gantt chart. The two accompanying illustrations are reproduced by permission from Mr. Wallace Clark's book, "The Gantt Chart." [6] Figure 158 represents a progress chart used in a machine shop manufacturing to customers' order. The angle opening to the right indicates the date on which each item was to be issued from stores; the figures indicate the numbers of the operations to be performed on each order and are placed under the dates on which they were to be begun, and the angle opening to the left indicates the date on which the parts were to be shipped. The heavy lines indicate what operations have been performed on each order, and the letters under the lines indicate the reason, for delay. The R under order 59064 indicates delay due to repairs, and since the chart indicates the time needed for the remaining operations, adjustments in the schedule can be made by the production manager to meet existing conditions. The V indicates that this chart was reproduced

[6] Wallace Clark, *The Gantt Chart, op. cit.*, pp. 87-94.

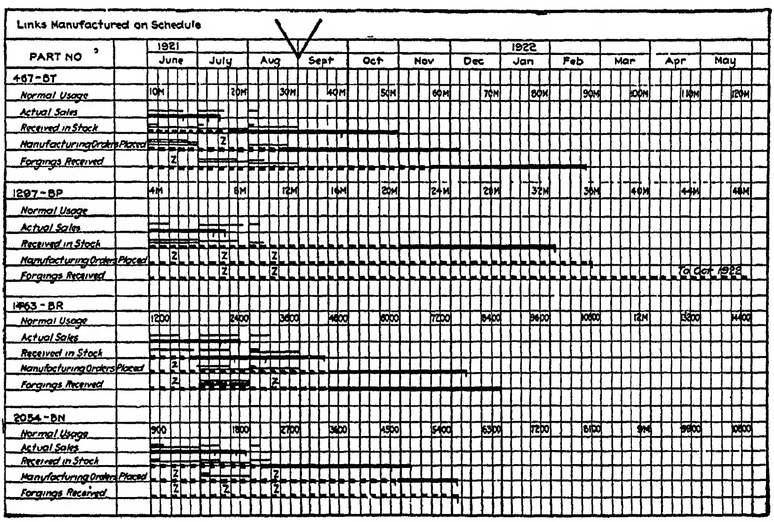
on March 3. If the work had proceeded exactly according to schedule, the heavy lines for all operations due to be completed on that date would



Courtesy, Wallace Clark and The Ronald Press

Fig. 158 Progress Chart Used in Machine Shop Manufacturing to Customers' Order. Postings have been made to this chart over a period of months, and it is being read on the date indicated by the V, March 3

end exactly under that date, except on those operations scheduled for prior completion. It will be noted that certain orders were ahead of, and certain ones behind, schedule. Figure 159 represents a progress chart



Courtesy, Wallace Clark and The Ronald Press.

Fig. 159. Progress Chart-Manufacturing to Stock. The date that this chart is being read is indicated by the V, September 1.

used in a plant manufacturing for stock. The figure at the left of a monthly space is the total scheduled for each month, the figure to the right indicating the total scheduled to date. The work done each month

is indicated by the light line, and the work done to the time of the preparation of the chart by the heavy line. Work done prior to June 1, when the chart was drawn up, is indicated by the dotted lines. Z signifies zero for the month. For one part, 1463-BR, the sales schedule was set at 1200 per month However, the amount of sales during the first three months fell short of this estimate. There were 960 in stock when the chart was drawn and during June 1050 were received, in July 720, and in August 1440, or a total of 3½ months' normal usage, as indicated by the heavy line. Deducting sales 1¾ months' normal usage is found to remain in stock. The heavy line on manufacturing orders placed indicates that this covers 2½ months' normal usage beyond the articles already placed in stock, while the number of forgings on hand is sufficient for more than another half-month's production.

It is necessary that this check-up by means of progress charts, or similar devices, be made a continuing process and one that is always kept up to the minute, because parts of assemblies, or whole orders, which once get very far behind schedule usually will throw many others out of schedule if the effort is made to bring them back into position. The effect of having to put extra pressure on one order is usually to require placing at least slightly extra pressure on a number of others later. Promptly to check up orders falling behind a carefully-worked-out schedule keeps the whole shop on its toes.

Scheduling and the plant executives. It will be well to understand the relationship of the foremen of the shop to the order of work. With centralized planning, the foreman comes into contact with the order of work but infrequently. In decentralized planning, it is often the foreman who makes out the order for his own department. In centralized planning it is most necessary that the foreman be given the responsibility of taking up with the planning department any order of work which he may feel is illogical.

The work of scheduling heads up in reports given to the works manager and other major executives of the concern. Besides a "balance of work" or "load ahead" report, which indicates unapportioned capacities, reports at periodical intervals may be made by the scheduling division which show:

1. A detailed list of all customers' orders in process.
2. A detailed list of all stock work in process.
3. A detailed statement of causes of delay or changes in the order of work which have held up production and which may be remedied or bettered by executive action.

CHAPTER XLVII

PRODUCTION PLANNING IN DIVERSIFIED MANUFACTURING —DISPATCHING

Dispatching includes the execution of all the plans of the routing and scheduling sections of the planning department. It consists largely of transmitting orders to the shop, is carried on coincidently with the operation of the schedule or order of work, but is purely a clerical function. Although, except in large plants, the operation of the order of work and dispatching are likely to be carried on by the same individual, for clarity of illustration they will be spoken of as if handled by two persons.

Central operation through the use of planning boards. In order to understand clearly all factors involved in these phases of production control, it will be best to consider first one basic system. This system will presume central operation of all phases of planning in a shop wherein the nature of the product and orders make necessary complete control of each separate operation. The type of jobs and size of lots will be varied and such that the operations will be long enough to make this control profitable, and yet short enough to allow at least three jobs to be planned ahead of each machine or workman. Changes in these basic conditions would necessitate changes in the system devised, as will be indicated later. This system will indicate the factors in production which must in some manner be controlled by the order of work and dispatching. It will be described in full detail, including all forms which are necessary for its operation. The factors include the workmen, the equipment, raw and worked material, tools, instructions, inspection, and shop transportation. To study this system is particularly valuable because it clearly controls each of these factors separately, and thus clarifies systems which combine control over several factors in production. The fundamentals of this system are probably used in more planning departments than those of any other, and many other planning systems are clearly developments which use this one as a basis.

The greatest aid in operating an order of work is some sort of continuous visual check on the condition of the shop.[1] The type of check here described is known as a bulletin board, or planning board (Fig. 160).

[1] See Fig. 140, p. 538 for the planning board used by the L. C. Smith and Corona Typewriters, Inc.

Through the operation of this bulletin board or its equivalent, those in charge of the order of work and dispatching have always before them an accurate picture of shop conditions, and through the added aid of the route sheets, the status of all orders. The planning-department bulletin board pictured is known as the three-hook type. Pairs of hooks are arranged in vertical rows in sets of three for each machine or work station. Each pair of hooks is utilized to indicate the position of work

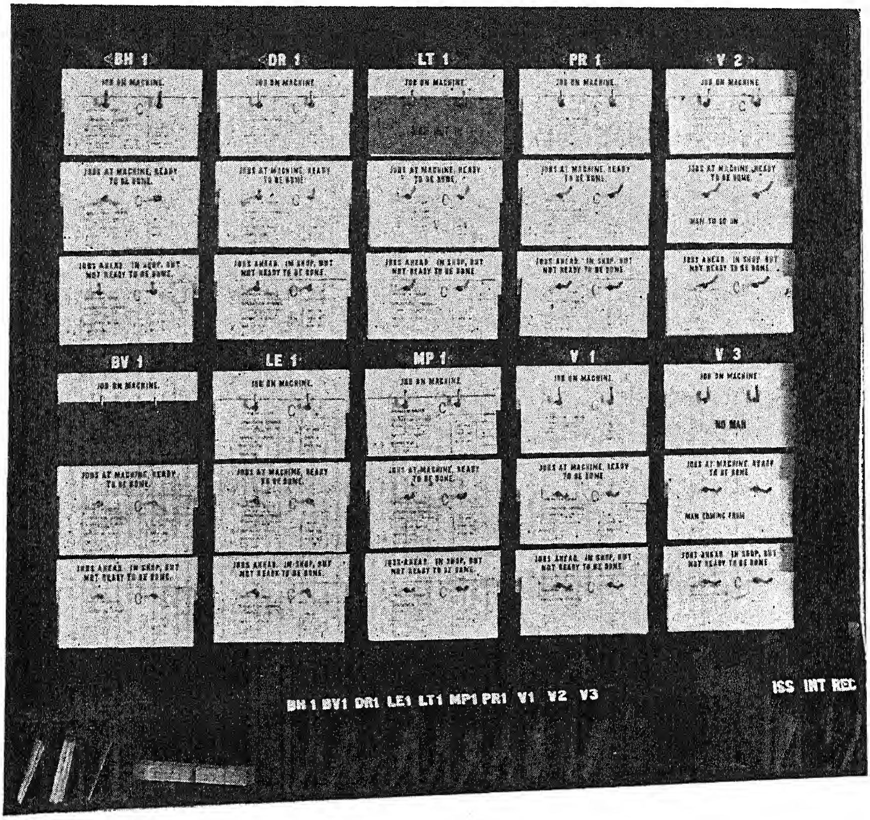


FIG. 160. Section of Planning-department Bulletin Board.

in the shop with respect to that particular machine or workplace. These hooks will be referred to hereafter as the first, second, and third hooks, and represent work in the following conditions as regards the machine or workplace:

1. The first hook represents work which is on the machine.
2. The second hook represents work at the machine ready to be done.
3. The third hook represents jobs ahead in the shop and tentatively assigned to the machine or workplace, but not yet ready to be done.

The lower portion of the board consists of a number of small compartments, one for each of the work stations shown on the board, and other compartments for miscellaneous uses. The compartments in the center of the board correspond to the machines or work stations which the board controls, and are utilized for filing tickets, relating to work assigned to the particular machine, in the manner hereafter described. The three compartments to the right are used for temporary filing of tickets that control the issuance of tools, drawings, and instructions, as will also be described. The other compartments may be used for miscellaneous purposes.

In each department of the shop there will also be found a shop bulletin board (Figs. 165 and 166) which will portray information concerning work for each machine or workplace in that particular department. This department bulletin board may be looked upon as a replica of that section of the central bulletin board which deals with that particular department. It is set up in the department for the purpose of more readily correlating the activities of the shop foreman and the central planning department, and does not imply, in any way, decentralized planning. The method of arranging tickets on this board will be spoken of later.

Indicating the order of work. The order-of-work or schedule man is constantly working toward the master schedule. He will determine from this the time at which it will be necessary to place an order or a component of an order in production. He must consult the route sheets pertaining to the order for the path to be followed through the shop. In operating the order of work, he must constantly consult the route sheets, since any determination of the time when an operation is to be performed must rest largely upon the availability of the machines or workmen involved. When an order is to be started, he must first consult the route sheets to ascertain whether material is available. He will determine this by consulting the checkmarks which have been placed on the route sheet opposite the heading, "Material apportioned and on hand" (Fig. 152, p. 574). In case he is dealing with an assembly operation he will consult the assembly route sheet (Fig. 153), and there ascertain whether the necessary material has been checked, "O.K." All such checks will have been made by the balance-of-stores clerk, who, since he controls stores, will have been in a position to place this necessary information on the route sheets. If material is available, the order or component may be placed in production.

To place an order in production involves taking certain of the dispatching tickets, which were prepared at the time the order was routed, from the files, and starting them through the routines which they affect. These will include *stores issues, identification tags,* and *move tickets.*

The stores-issue forms were partially considered when the operation of the store-room was described. They are prepared from the route sheets, and filed after they have first passed through the hands of the balance-of-stores clerk. The latter at that time utilizes the information upon them to increase the apportioned column of the proper balance sheets, correspondingly to decrease the available column, and to take such other steps as may have been made necessary, as, for instance, to order materials. When the order-of-work man removes the stores issues from their file, they again pass through the hands of the balance-of-stores clerk. This enables him to write off the material which is being issued from the On Hand and Applied on Orders columns. The task of forwarding stores issues to the storeroom is a function of dispatching. Usually,

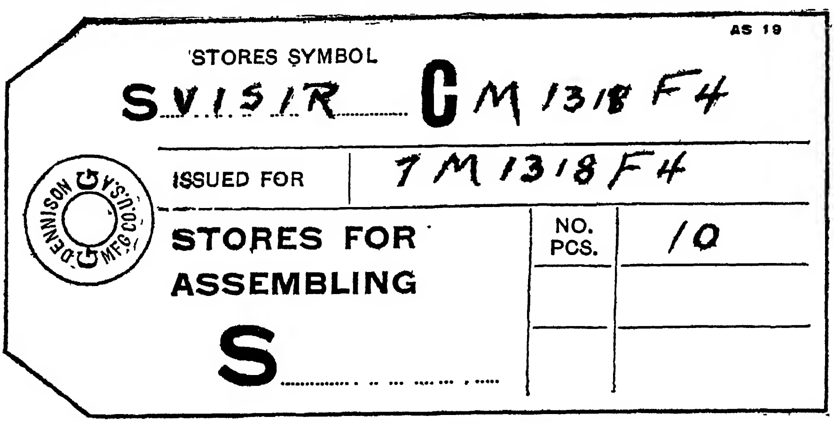


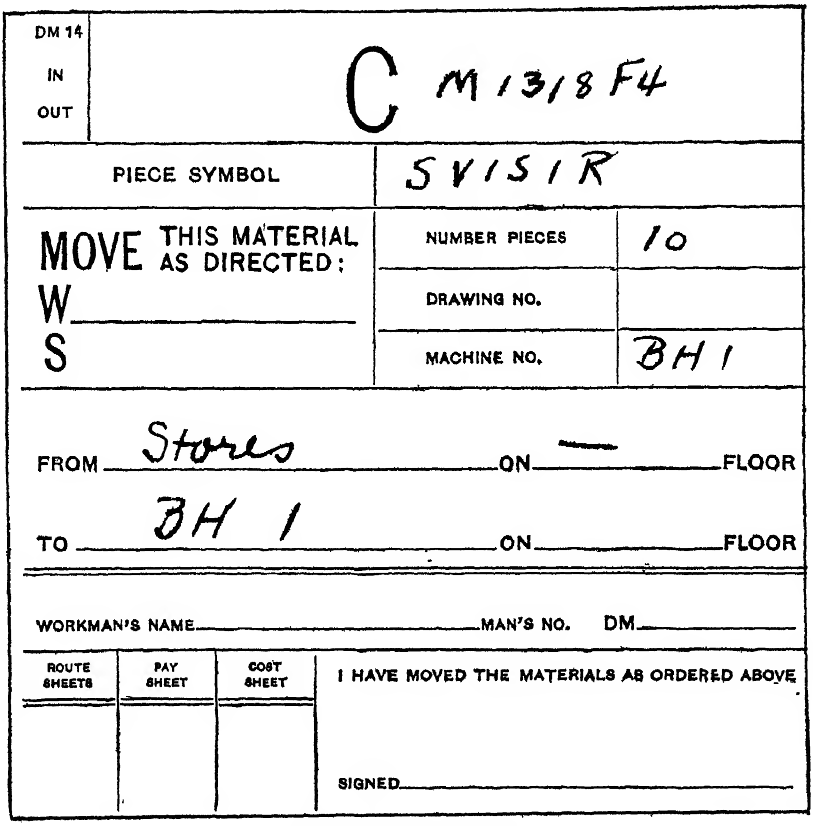
Fig. 161. Identification Tag.

it is only necessary for the order-of-work clerk to place the issues in a designated place, which will indicate to the dispatcher that these slips are to be forwarded to the storeroom and the corresponding orders thereby placed in production.

At the same time when the dispatcher sends a stores issue to the storeroom, he sends along with it the necessary number of stores identification tags, which have already been prepared and filed (Fig. 161). Such tags are attached to all stores issued and stay with the materials throughout the production process, thus clearly identifying them with the production order on which they are being used. The move ticket (Fig. 162) is now sent by the dispatcher to those in charge of interior shop transportation, as authority to move the material in question from the storeroom to the department and production center where the first operation is to be performed. If the route sheet indicates alternate machines on which a given operation may be done, the writing of the move ticket is at times left to the dispatcher, and he will select the

machine by consulting the planning board regarding availability. Identification tags and move tickets are often profitably combined in a manner later explained.

The set of check columns on the route sheets used for recording the performance of designated operations now comes into play. The columns are headed "move," "operation," "first inspection," and "final inspection."[2] A check is made by the dispatching clerk when he orders the



DM 14
IN
OUT

C M 1318 F4

PIECE SYMBOL 5V1S1R

MOVE THIS MATERIAL AS DIRECTED:
W
S

NUMBER PIECES 10
DRAWING NO.
MACHINE NO. BH1

FROM Stores ON — FLOOR
TO BH 1 ON FLOOR

WORKMAN'S NAME MAN'S NO. DM

ROUTE SHEETS | PAY SHEET | COST SHEET

I HAVE MOVED THE MATERIALS AS ORDERED ABOVE

SIGNED

FIG. 162. Move Ticket

performance of any of these functions on any operation indicated as necessary by the route sheet. For instance, when he issues the move ticket and orders the materials from stores to the first operation, he might draw a vertical line halfway down the small space under "move" and opposite the first operation, thus indicating that he has ordered this action. When the move has been completed, those in charge of shop transportation return the move ticket to the planning department, noting

[2] See route sheets (Figs 152 and 153), p. 574.

upon it that the move has been made. This information might then be posted by the dispatching clerk to the route sheet by completing the vertical check under move and opposite the first operation. Anyone who might consult the route sheet would, therefore, be informed im-

	DM 15 OPERATION ORDER	C	M 1318 F 4	
	OPERATION SYMBOL		7MF	
	TO EARN BONUS, WORK MUST BE DONE IN	2.48	NO. PCS.	10
	AMOUNT OF BONUS		DRAW. NO.	53748
IN OUT	WANTED FOR		MACH. NO.	BH 1
	HOLD FOR			

FIG 163. Operation Ticket Planning department bulletin-board copy (white), shop bulletin-board copy (manila).

mediately as to the status of that particular order at that time, namely, that the material was at the machine ready for the first operation, but that this operation had not yet been performed.

Immediately upon receipt of information in the planning department

DRAWING AND INSTRUCTION CARD ISSUE	DM 3 OPERATION ORDER	C	M 1318 F 4	
OPERATION SYMBOL			7 MF	
NUMBER OF INSTRUCTION CARDS		1	NO PCS.	10
NUMBER OF TOOL LISTS		1	DRAW. NO.	53748
ISSUED BY SIGNED	RECALLED BY SIGNED		MACH. NO.	BH 1

FIG. 164. Operation Ticket. Drawing, tool, and instruction card issue copy (pink).

that material has been moved to a production center, the scheduling function with respect to indicating the order of work again becomes important. At the time when the order was routed, there were placed on the third hooks of each machine or workplace affected by the order, triplicate copies of an operation ticket (Figs. 163 and 164). This ticket

describes and controls the operation to be done on that machine in connection with that order. The tickets hanging on the third hooks will at any time clearly indicate the balance of work ahead of each machine or department not yet placed in production. If alternate routing to a group of machines is provided by the route sheet, the operation tickets usually will be hung on the third hooks of one machine of the group previously designated. When material is moved to a production

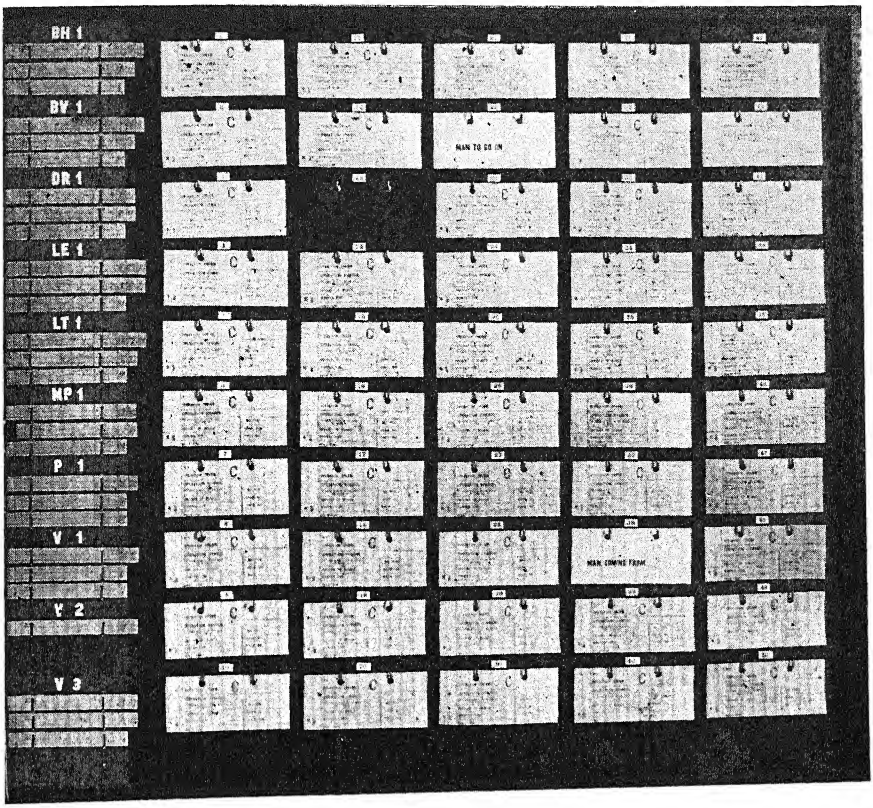


FIG. 165. A Shop Bulletin Board.

center, the order-of-work man must remove the proper triplicate set of operation tickets from the third hook and place two of these in proper sequence on the second hook. *The position in which he places them on the second hook will determine the order of work for that operation on that machine with reference to other operations already scheduled for the machine.* He will determine the position according to the needs of the master schedule. The two copies that are placed on the second hook are the planning-department bulletin-board copy (Fig. 163) which will

primarily control sequence (white in color) [3] and the drawing, tool, and instruction-card issue copy (pink in color) (Fig. 164). At the same time that these two copies of the operation order are placed upon the second hook, the manila or shop bulletin-board copy is taken to the shop board and placed there.

The shop bulletin board illustrated in Fig. 165 consists of two sections: on the right a series of pairs of hooks serially numbered; on the left a series of clips under headings for each machine or work station in

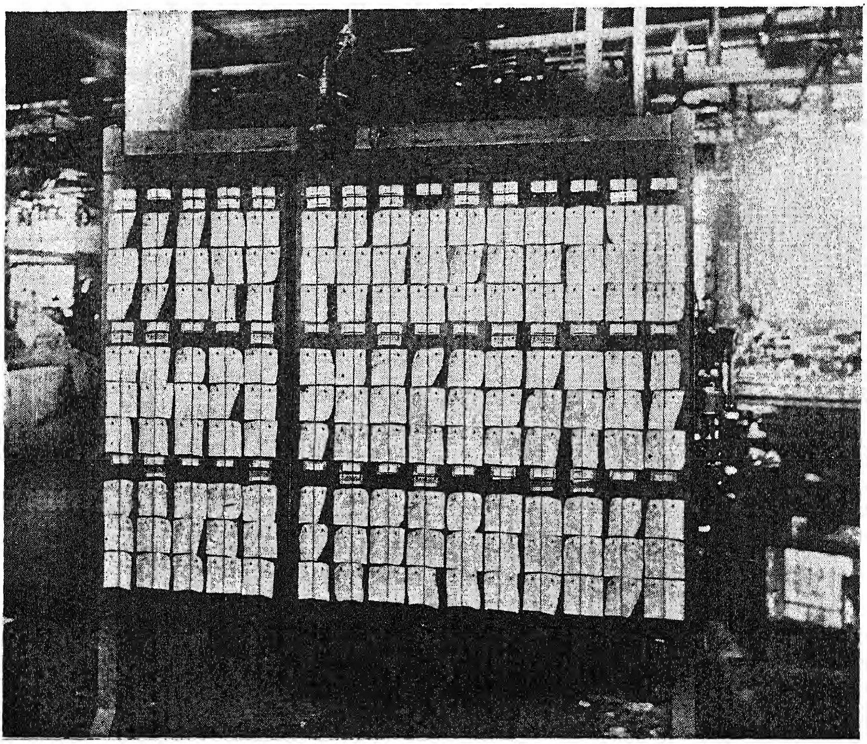


FIG. 166. Shop Foreman's Bulletin Board, Universal Winding Co., Providence, R. I.

the shop. When the shop copy of the operation order is placed on the shop bulletin board, it may be hung on any one of the serially numbered pairs of hooks which may at the time be vacant. At the same time that this operation order is placed on this pair of hooks, there is placed under the machine heading a strip of cardboard on which is found a number corresponding to the serial number of the hooks on which the operation order is hung. The relative position of this strip of cardboard to other similar strips under a machine heading indicates the order

[3] Any color combinations may be used.

of work for that particular machine, and corresponds exactly to the order of work as found on the second hooks of the planning-department board. Another form of shop board, used at the Universal Winding Company, as illustrated in Fig 166, provides for the placing of operation orders in sequence directly under the machine numbers Either method gives the necessary flexibility of operation.

Conditions of a particular shop will determine the number of operations for which material should be on hand at any production center, and also the number of these for which tools, drawings, and instruction cards should be on hand. Unless the tools be special, they will be used on more than one operation, and it is, therefore, not wise to have too many waiting at the production points. The pink operation ticket controls the issuance of the tools, as well as the drawings and instruction cards; and on shop conditions, and on the number of jobs ahead of a machine will depend largely the handling of this ticket. It may not be placed upon the second hook at all, but may be used immediately to order the tools, drawings, and instruction cards to the shop. Or, if there are a number of operation tickets on the second hooks, it may be placed on the second hook with the white operation ticket, as already indicated, until it is the second or third job ahead. In any case when it is desired that the tools, drawings, and instruction cards be issued, the pink operation ticket is placed in the small compartment in the lower right-hand portion of the planning board marked "ISS" or issue. These tickets are periodically collected by a messenger, who, consulting them, takes the proper instruction cards and tool lists from the files and any necessary drawings from the drawing cabinet to the work station. The tool lists are subsequently forwarded with the requisite number of tool checks by the foreman to the tool room, as a requisition for the necessary tools for the operation. This procedure insures the utilization of standard tools for the operation. The pink ticket is then filed in the central section of the bulletin board under the machine number, thus indicating that the instruction cards, drawings, and tools are at the machine and the operation is thus ready to be performed.

Dispatching to the workman. Let it be assumed that a workman has just completed an operation on a machine. He brings or sends to the dispatch window of the planning department the time ticket (Fig. 167) which had been issued to him at that same window at the beginning of the operation. This time ticket is stamped with the time of receipt and the workman is ready to receive a new time ticket for his next job. The dispatcher consults the bulletin board and ascertains which job is next on the order of work on the second hook of that machine. He places this operation ticket on the first hook after removing the operation ticket for the job just completed. He then proceeds to the route

file, removes the time ticket and inspection ticket (Fig. 168) for the new operation, hands the time card to the workman, and forwards the inspection ticket to the inspector. At the time that the dispatching clerk hands the time ticket to the workman, he draws on the route sheet a half check line under the headings "operation" and "first inspection" for that particular task. At the time that the workman brings back his time ticket, indicating that the work has been completed, the dispatcher com-

DM 6
IN
OUT

C

FIRST TIME CARD
AND BONUS RECORD

M 18 24 4 J P 1

TOTAL WAGES $	OPERATION SYMBOL	4 M J P			
MACH. TIME	TIME ALLOWED	BONUS TIME	BONUS WAGES	No. PCS.	50
	3.25		$	DR. No	56482
IF JOB IS NOT FINISHED SCRATCH OUT THIS ☞ F		IF JOB IS FINISHED SCRATCH OUT THIS ☞ NF		MACH. No.	BH 1

									TOTAL
DAY									
PIECES FINISHED									
TIME UNITS									

WORKMAN'S NAME — MAN'S NO. DM.

I HAVE CHECKED THESE ENTRIES AND BELIEVE THEM TO BE CORRECT:

HRS. X COST No. — SIGNED BY FOREMAN

ROUTE SHEETS	PAY SHEET	COST SHEET	BONUS EARNED BONUS NOT EARNED	
			THE ABOVE WORK HAS BEEN INSPECTED AND FOUND O. K. DEFECTIVE	

Fig. 167. Time Ticket.

pletes this check line. After the inspector makes his first, or check inspection, the inspection ticket is returned to the dispatcher who completes the check line under first inspection. This use of the route sheet as a progress chart clearly illustrates the desirability of having it filed in such a manner as to be readily accessible.

Upon receipt of the time ticket from the worker at the completion of the operation, the inspection ticket is reissued to the inspector for recording of final report as to quality and number of the lot that is good

and can be continued in process, and a half check line drawn under that column. Upon receipt of the final inspection report from the inspector, this line is completed. The time and inspection tickets are now forwarded to the rate-setting or cost department for addition of bonuses, deduction of penalties, and general payroll purposes, as well as for entry on the necessary cost records

Upon the receipt of the final inspection ticket from the inspector, the

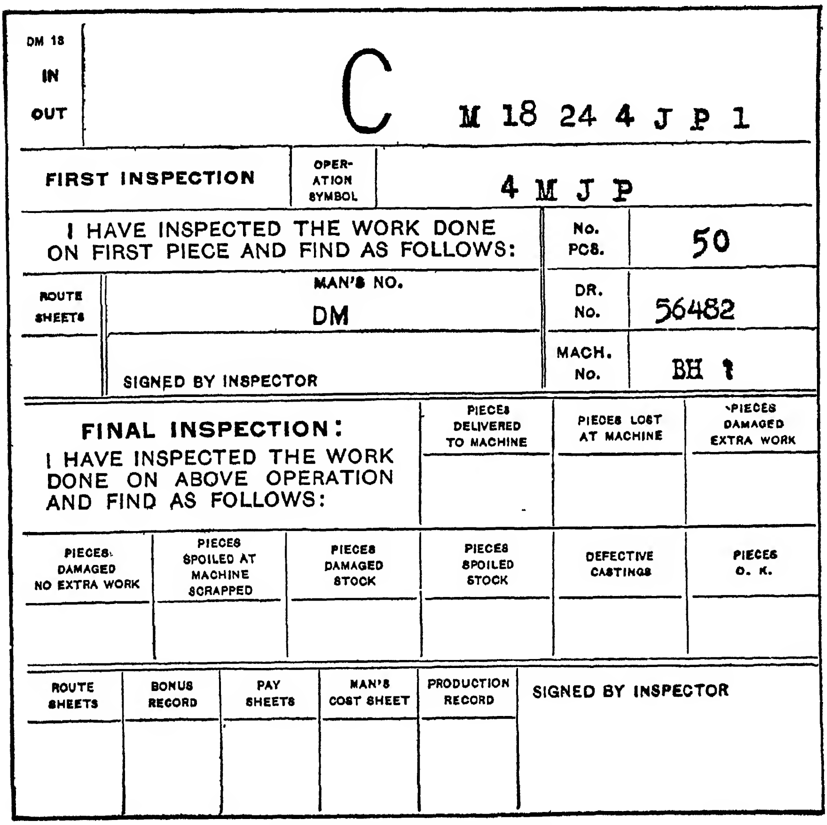

DM 18
IN
OUT
C M 18 24 4 J P 1
FIRST INSPECTION
OPERATION SYMBOL
4 M J P
I HAVE INSPECTED THE WORK DONE ON FIRST PIECE AND FIND AS FOLLOWS:
NO. PCS. 50
ROUTE SHEETS
MAN'S NO. DM
DR. NO. 56482
SIGNED BY INSPECTOR
MACH. NO. BH 1
FINAL INSPECTION:
I HAVE INSPECTED THE WORK DONE ON ABOVE OPERATION AND FIND AS FOLLOWS:
PIECES DELIVERED TO MACHINE
PIECES LOST AT MACHINE
PIECES DAMAGED EXTRA WORK
PIECES DAMAGED NO EXTRA WORK
PIECES SPOILED AT MACHINE SCRAPPED
PIECES DAMAGED STOCK
PIECES SPOILED STOCK
DEFECTIVE CASTINGS
PIECES O. K.
ROUTE SHEETS
BONUS RECORD
PAY SHEETS
MAN'S COST SHEET
PRODUCTION RECORD
SIGNED BY INSPECTOR

Fig. 168. Inspection Ticket.

pink operation order controlling the drawings and instruction cards is removed from the receptacle under the machine number at the bottom of the planning board, and placed in the lower right-hand corner of the planning board under the heading "REC," signifying recall. This is a signal to the messenger to bring back all drawings, instruction cards, and tool lists from the machine or workplace to the planning department, where they are properly filed. It is a function of the foreman to see that tools are returned to the tool room at this time.

Upon the receipt of the final inspection ticket, there is issued the move ticket for the next operation as indicated by the route sheet, and a half check line is drawn under the move column for this operation. Upon the receipt of this move ticket, those in charge of shop transportation move the worked materials from the machine where the work has been completed to the machine or workplace where the next operation is to be performed. They then return the move ticket to the planning department, a full check line is drawn under the heading "move" for this operation, and all procedures, as explained above for the first operation, continue for the second and other succeeding operations in exactly the same manner.

If a job be interrupted and the operation postponed for any reason, the operation ticket is removed from the first hook and placed on the second hook, in conformity with the proper order of work. At the same time all drawings, instruction cards, and tool lists are recalled from the shop, if the delay is to be a long one. Such recall is accomplished through the removal of the pink operation ticket from under the machine number at the bottom of the planning board. This ticket is placed in the lower right-hand compartment headed "INT," signifying interruption. The messenger, observing the pink slip in this location, brings all papers from the shop and files them.

Control of shop conditions through the planning board. Shop conditions may be told at a glance by reference to the planning board if cards are provided to be hung on that board, which will clearly give such information concerning each work station. For instance, there may be an operator's card, containing the operator's name and number, and a list of the machines or workplaces which he is qualified to operate or at which he is qualified to work. This card, hung on the first hook of the machine at which the man is working, gives the planning department an unusual ability to control men to best advantage, and particularly to suggest to the shop foreman changes of men between machines in cases of emergency. A card with the words "No Man" printed upon it may be hung under any machine where there is work to be done, but no operator available. A "Man Not In" card may be used to indicate that an operator is absent. A "Machine under Repair" card may be used to indicate that a machine is shut down for repairs. "Man to go on—" and "Man coming from—" cards may be used to show the planned transfer of workers from one workplace to another after a current operation is finished. These cards are usually in distinctive colors which will enable members of the planning department quickly to visualize shop conditions. Some plants, in place of certain of these cards, prefer a "Machine Inactivity Card," such as illustrated in Fig. 169, on which the relevant information may be checked. This card may be time-

stamped and forwarded to the cost department for computation and distribution of idle time costs.

Description of important forms used in dispatching. The time ticket serves more purposes than any other form used in dispatching. It informs the worker of his rate (if this is not on the instruction card). It records the length of time consumed in the operation, and is, therefore, a basis for all cost computation and wage payment, and it is a vital link

Ret. Iss'd		Machine______ Location		
MACHINE INACTIVITY CARD				
Check Reason for the Inactivity of the Machine with Cross (X) in the Column to the Left of the List Below.				
	Lack of Man			
	Lack of Material			
	Lack of Work Assigned			
	Lack of Supplies			
	Machine Under Repairs			
Signed______				
Remarks______		Machine Time	Hourly Machine Rate	Inactivity Cost

Fig. 169. Machine Inactivity Card.

in the dispatching system. The amount of information which must be placed upon it, therefore, is great, particularly compared to a ticket, such as the operation ticket, which is used only for control. Duplicate copies of time tickets may well be used to replace operation tickets, unless it be felt that the larger amount of information on the time ticket may lead to confusion, or to using too much space on the planning boards. Figure 167 is an example of a time ticket which will indicate the basic information necessary on such forms. The order which is to be

charged with the labor represented by the ticket must be indicated, as well as the operation number, which will make possible allocation of costs to operations or departments. Provision must be made to indicate the time when the ticket is issued and returned. The time when the job is completed is stamped above the time when it is begun, to permit of easy subtraction of elapsed time. If an incentive wage system be used, it is desirable to indicate standard time, the base rate, and the bonus earned on the time ticket. At the bottom of the ticket there are check spaces headed "Route Sheet," "Pay Sheet," and "Cost Sheet," to provide for checking proper posting of the time ticket.

One of the more recent developments in time tickets provides for the use of tabulating machine cards, as illustrated by Fig. 170. All the necessary information can be written on the card, and then when

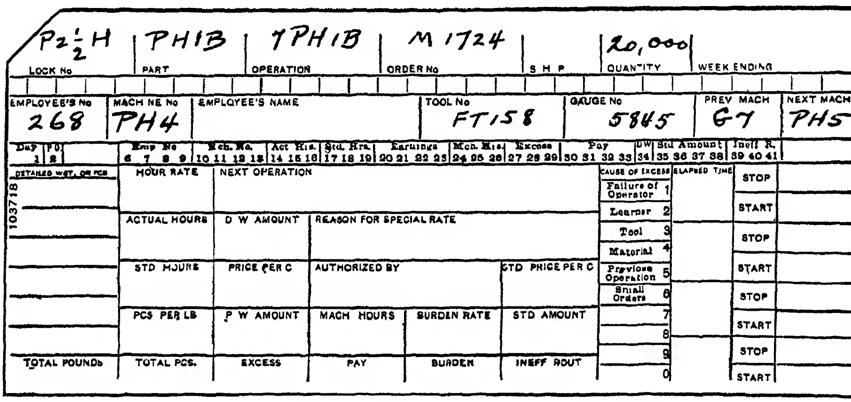
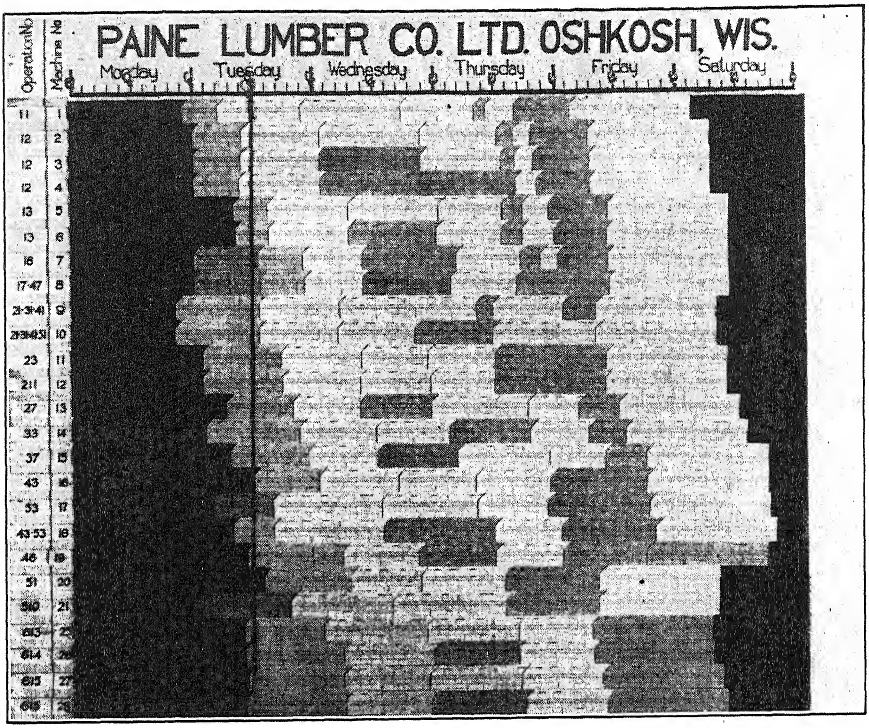


Fig. 170 Time Ticket for Use in Tabulating Machine.

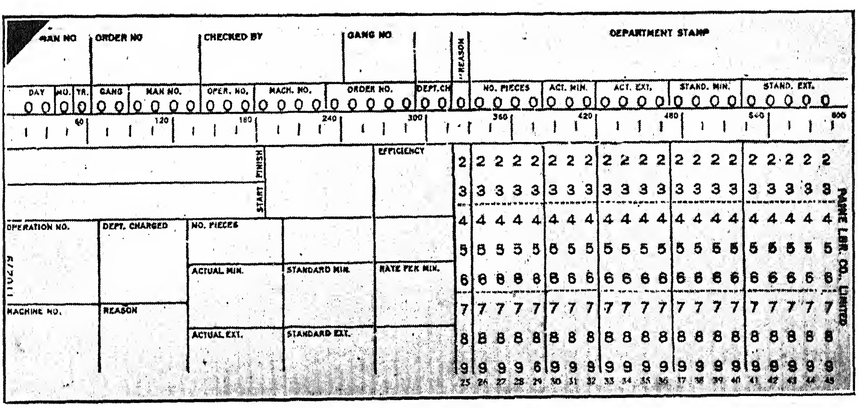
full use has been made of this, the card can be punched, on the basis of this information, for use in the tabulating machine. The cards can then be run through the tabulating machines and information concerning general shop conditions, conditions of work, or wage payment quickly secured. Some plants are using carbon copies of tabulating-machine time cards for control of operations in the usual way.

Many types of planning boards have been constructed. A simple board which is effective and uses tabulating-machine cards for time tickets (Fig. 171), has been used by the Paine Lumber Company at Oshkosh, Wisconsin. J. J. Davis, industrial engineer of this company, has described the operation of this board as follows: "The basis of the scheme is a job card for each operation to be performed on each job or order, on which is entered, on a special line, the time required for the operation. (See Fig. 172.) A heavy line of the proper length is then drawn through the scale to represent the time required. . . . On the



Courtesy Paine Lumber Company, Ltd.

FIG. 171. Planning Board Using Tabulator Time Cards for Scheduling Work and Dispatching Jobs to Workers.



Courtesy, Paine Lumber Company, Ltd.

FIG. 172. Tabulator Job Card Used with Planning Board in Fig. 171. Note the time scale in the third horizontal field from the top.

left of the board all operations performed in the department are indicated by symbols, together with the machines or other equipment upon which they are performed. . . . Across the top is a time scale corresponding to the scale printed on the cards. Hooks at top and bottom of the board hold an elastic tape to aid in locating current time. They are spaced for each half day . . . If separate cards are desired for several workmen performing one operation, they are all filed together. . . . The cards for each order or lot are separated according to the length of the line drawn on the scale. The time required for each operation determines the time at which succeeding operations may start, and at which similar operations upon other parts should start, and at which assembly may start without being delayed for parts. When all cards for jobs ahead are properly filed, the board then presents a complete picture of work ahead of the department. To aid interpretation of this picture, pink cards are inserted to indicate idle equipment and workers, which are changed to green cards when other work has been provided for the operators. A messenger or workman from each crew comes to the board with cards representing completed order or lot, and takes cards for new orders with complete instructions, leaving exposed a colored card filed back of work cards indicating job in process on each operation. The method of filing cards makes it very convenient to change the plan and provide for machine breakdowns, absent help, variations in actual time consumed on any operations, etc. This feature of flexibility makes it possible to provide for such irregularities and emergencies with the least possible interruption of assembly or completed work, as well as to lay out the work in one way and then try to work out a better rotation." [4]

Check spaces on forms. A most important part of any form used in control is the series of check spaces provided to insure the performance of all tasks that deal with the information covered by the form. Manufacturing orders, time and job tickets, and other forms which are the basis for a procedure involving two or more persons may all have these check spaces provided. They not only permit quick placing of responsibility for errors made, but also prevent errors and oversight, and insure that once a procedure is started, all necessary steps in connection with it will be taken.

[4] *The Society of Industrial Engineers Bulletin*, Vol. 9, No. 11, p. 3.

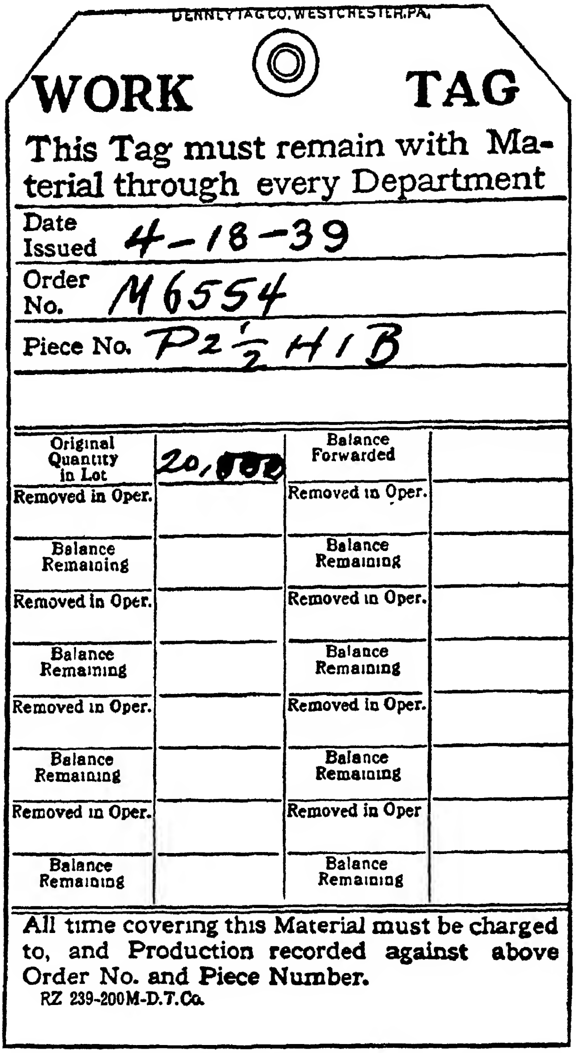
CHAPTER XLVIII

ADAPTATION OF PRODUCTION-PLANNING METHODS IN DIVERSIFIED MANUFACTURE

Since the purpose of production planning is to control operations in such a way that they will be performed on time and at lowest cost, care must always be exercised that planning schemes do not slow up production. If the planning system be so arranged that much time is taken by the workman in the exchange of job cards, or if there must be provided an inordinately large clerical force to handle the planning procedure, the difficulty probably is that the planning has been attempted on too exact a basis, and that in the attempt to reach exactness, costs have been unnecessarily increased. Ninety-eight per cent perfect planning is likely to prove more profitable than planning which reaches 100 per cent perfection. Thus, in routing work, alternate machines may well be indicated, though it will prove profitable to call attention to the excess costs of production on the alternate machine. In developing an order of work, if 100 per cent perfection be the goal, it is probable that alternate provisions for work for a machine will not be made, on the assumption that the work which has been planned ahead will always be ready. If 98 per cent perfection be set as the goal, the planning department will be likely to have made some general arrangements to take care of the hold-ups which will inevitably occur, and therefore, in the long run, the control of production operations will be smoother.

Minor modifications of the typical procedure. If any advantage is to be gained from the pages on order-of-work and dispatching procedure, *it is essential that the form be not misunderstood for the essence.* These pages form a ready basis for adaptation and simplification. They clearly indicate a unified method of controlling all the factors of production which must be currently controlled while an order is in process. One method of developing planning boards in a different manner has been described in detail. Some companies, instead of using planning boards with hooks, use pockets or boxes for the distribution of tickets controlling operation, as in Fig. 154, p. 576. Many plants utilize a two-position planning board, rather than a three-position board, as described. In such cases, jobs are not posted until an operation is ready to be performed, the operation tickets being retained in file until that time. The balance of work, instead of being secured from a third position, is secured from some sort of a load chart.

Adaptation of centralized planning procedure. It was mentioned that the system of centralized order of work and dispatching which has been described is an excellent one to consider, because of the clear separation, under it, of the control of each of the various factors of production. Some of the more frequent forms taken by adaptations of this procedure involve combination control over several of these factors, or the issuance of the control orders in a somewhat less formal way that often tends to speed up production.



DENNEY TAG CO. WEST CHESTER, PA.

WORK TAG

This Tag must remain with Material through every Department

Date Issued 4-18-39

Order No. M6554

Piece No. P2 1/2 H1B

Original Quantity in Lot	20,000	Balance Forwarded	
Removed in Oper.		Removed in Oper.	
Balance Remaining		Balance Remaining	
Removed in Oper.		Removed in Oper.	
Balance Remaining		Balance Remaining	
Removed in Oper.		Removed in Oper.	
Balance Remaining		Balance Remaining	
Removed in Oper.		Removed in Oper	
Balance Remaining		Balance Remaining	

All time covering this Material must be charged to, and Production recorded against above Order No. and Piece Number.

RZ 239-200M-D.T.Co.

FIG. 173a. Combination Identification Tag and Move Ticket (Front).

Combination identification tag and move ticket. Inasmuch as the route which materials are to take is, in general, determined before the materials leave the storeroom, one of the first moves in changing the described procedure is usually the elimination of the move ticket. The identification tag may be somewhat enlarged, and on the back may be placed the route through the plant. As one operation is completed the move may be ordered by the inspector who has passed the materials, or if there is no inspection needed at that point in the process, as is often the case, the move man may receive orders to move from the shop foreman. In such cases the movement of the material is reported to the planning department at the same

time that the inspection report or the job ticket is handed to them. They have continual knowledge of the location of the material, but they order the movement from each operation at the time that they first order the goods from the storeroom. If minor changes need to be made, these can easily be made on the identification tag when the goods are in process, by a representative of the planning department. Such a tag is illustrated in Figs. 173*a* and 173*b*.

Combination time, inspection, and move ticket. Some plants have retained the identification tag in its original form but have combined the move ticket with the time ticket. Possibly the inspection ticket is replaced by space on this same form (Fig. 174). Thus, when a time ticket is issued to a worker, there is noted on the bottom of the ticket the next operation and where it is to be performed When the operation has been performed, the foreman directs the move man to take the materials to the location specified, and reports this action upon the form. Prior to such movement, the inspector will have inspected the operation and will make his report on the same ticket. Thus the planning department need only order performance of an operation, and inspection and movement follow automatically. This gives the foreman

	Operation	Workman	Inspector
PA 17			
PD 7			
PD 9			
MP 5			
T 2			
G 7			
PH 4			
PH 5			
PD 22			
G 4			
T 2			
X 8			
X 11			

FIG. 173*b*. Combination Identification Tag and Move Ticket (Back).

somewhat more direction of the production process. It reduces the number of forms which have to be handled, and in most cases does not materially lessen the amount of planning-department control. Proper modifications must be made in such cases in the checking of progress on the route sheet and the issuance of new job cards to the worker. Time must ordinarily be

RETURNED ISSUED					CHARGE TO M 1318 F 4			
AP 34								
OPERATION NUMBER 7 MF	KIND OF OPERATION Assembly							
A=PREMIUM LIMIT HOURS	2.48		MAN'S RATE	MAN'S TIME		TOTAL EARNINGS	MACH. NO.	LOCATION
B=TOTAL HOURS TAKEN								
I HAVE INSPECTED THE ABOVE MATERIALS AND FIND THEM								
SIGNED BY INSPECTOR								
MOVE ABOVE MATERIALS From BH 1	To LE 3							
NO. OF PIECES MOVED	RECEIVED BY							

FIG. 174. Combination Time, Inspection, and Move Ticket

stamped on the time cards by the foreman or his representative in the shop, and issuance of new job cards must be on the request of the foreman, as he sees that the worker is nearing the end of the job. This change is made necessary by the retention of the time ticket in the shop until after final inspection of the operation.

Location of dispatch stations in the shop. In plants of any size where central planning is retained, it is desirable to locate dispatch stations in the shop, or to provide pneumatic tubes through which time tickets may be transmitted. Because of the expense of the latter and the desirability of direct contact between the workman and the man who

is handing him his job, the first alternative is usually adopted. Dispatch stations in the shop do not imply decentralized control. They merely issue the tickets which they are told to issue by the central planning department. Perhaps they have some control over movement of material. At any rate, in large plants, they save steps and time for the worker. To have the worker come to the window of the planning department for his new time ticket is possible only in small plants.

Strip operation tickets. Where the sequence of operations is practically standardized, regardless of the particular style of product being manufactured, as in a shoe, men's clothing, or a hosiery plant, it becomes profitable to control operations in groups through the use of strip operation tickets. Such a ticket is illustrated in Fig. 175. This ticket is assigned a number and attached to the batch of materials as it is about to start through a series of operations. It has a coupon for each operation in the series. As the worker performs an operation, he detaches a coupon, part of which he usually gives to his supervisor for transmission to the planning department, and part of which he retains for purposes of checking with his pay envelope. This portion of the coupon for the worker is made necessary since there is no direct check with him to insure that he has received credit for the work that he has done. He receives such credit only as a batch of tickets is turned into the planning department. Where operations are short and must be performed in the same sequence, this gives all the necessary control for the planning department and at the same time allows the goods to flow through the factory promptly.

A number of different strip tickets can be provided for the whole sequence of operations, each ticket covering a controllable unit. The order of work can be maintained throughout the sequence of operations covered by one ticket, if the numbers on the tickets correspond with the order of work, and if the batch or lot of goods with the lowest serial number is put through each operation first. Manifestly, serial numbers can be changed at the end of each series of operations. Movement of material at the end of a series of operations must be on separate order from the planning department, as in the case of any other system. Where inspection is necessary after operations, it is usually treated as one of the operations covered by the strip ticket.

Planned control of filling orders in wholesale houses and mail order houses. Although our discussions have been built around the manufacturing process, the student should not gain the impression that planning for the use of man power and operations is confined to manufacturing. The construction of a building or ship requires very accurate planning for materials and synchronizing of the work of the various craftsmen. The general farmer plans his work so that he can make most

F 104

22006 Report Inspector — Date — Date

6

	First		Second			No.	Date
Seconds					Knitter		
O. K.					Trimmer		
Topper M					First Inspector		
Machine M					Looper		
Looper M					Second Inspec.		
Total					Mender		
					Re-Inspector		

Style 103 Size 9 1/2

22006

5

			Doz.	Odds
Inspector		Good		
Re-Inspector		Mended		
Mender		Total		

Style 103 Size 9 1/2

22006 Date Style 103 Size 9 1/2 Re-Insp. Doz. Odds.

22006 Re-Inspector 4 Date Doz. Style 103 Size 9 1/2 @

22006 Date Style 103 Size 9 1/2 Mender Doz.

22006 Mender 3 Date Doz. Odds Style 103 Size 9 1/2 @

22006 Date Style 103 Size 9 1/2 Sec. Inspec

22006 Sec. Inspector 2 Date Style 103 Size 9 1/2 @

22006 Date Style 103 Size 9 1/2 Looper

22006 Looper 1 Date Style 103 Size 9 1/2 @

Fig. 175. Strip Operation Ticket.

effective use of his time and acreage. The department store must plan its use of salespeople, provided it keeps open longer hours than the work week allowed without overtime. It must also plan the delivery of its merchandise to avoid having its delivery trucks running partially loaded. Probably the most complete planning control of work outside of manufacturing is that required by the large wholesale houses and the mail order houses. These are similar in principle, although differing somewhat in detail.

The mail order houses estimate the volume of work for the day by weighing the incoming mail. Principles of motion economy and plant layout are used by the large mail order houses. They employ industrial engineers who constantly study operating conditions. Definite routes are followed by incoming orders. They are first opened by an envelope-slitting machine, after which they move on a belt conveyor, past readers who remove the contents, count the money, and place the money in separate containers to go to the finance division. The orders then proceed to other clerks along the conveyor who read them and interpret items that may be confusing. These orders also pass by girls who price each item, and others who edit them for filling by the order-filling clerks. Copies are typed for each department which may have an item on the order. The shipping label is prepared in the central control office. All of the required information is assembled by the central office and a group of orders is released at one time called "blocks." These blocks may be of sufficient quantity to require a definite length of time to be filled, such as twenty minutes. Naturally the number of employees filling orders and the nature of the orders will influence the number of orders in a "block." All items for a given order, provided they are in stock, meet in the wrapping and shipping department where they are assembled in one package if possible, weighed, routed as to parcel post, express, freight, etc., and started on their journeys to their respective buyers. The mail order houses strive to ship all orders within twenty-four hours after the receipt of the order. This is adhered to with a high degree of performance. When it is recalled that literally thousands of orders ranging from one thimble to many orders including lineoleum, mattresses, etc., are handled daily, the magnitude of the task can be appreciated. Such performances are real tributes to the effectiveness of scientific management in the merchandising field.

Operation of decentralized planning control. Decentralized planning control is almost a necessity in very large plants, and where entirely different types of businesses are carried on within one building, as in the case of the manufacture of stationery and the boxes in which the stationery is sold. Decentralized control is frequently set up when it is the desire of the management to allow the foremen to retain a consider-

able share of the task of planning the work. It has already been indicated that the development of the master schedule and routing between departments are functions which must be performed centrally. Portions of the other planning functions may be decentralized.

Routing to machines is the planning function which is most frequently left to the department planning supervisor. If this function be given to him, of necessity much of the operation of the order of work will automatically go with it. If there be decentralized control, dispatching to the worker will always be done within the department. If routing is to be given to the shop planning supervisor, whether he is or is not under the control of the foreman, there are usually certain operations which must be routed centrally. These are the key operations, or operations which may be done on only one or two machines. This is desirable to prevent throwing the shop out of balance.

If there are departments which have large batteries of the same kind of machines, all capable of doing essentially the same kind of work, ideal conditions for decentralized routing are found, because the foreman or the shop planning supervisor will ordinarily be in a much better position to determine the machine to which a particular job should go than would be the central planning department. In such cases, the routing of material to the department, nearly always a function centrally performed, is in reality routing to a particular group of machines. The decentrally controlled routing takes on the nature of a dispatching function, which will indicate the machine of the group, which, from the standpoint of shop conditions, is best able to take on the particular operation. If routing of this nature be done decentrally, the central route sheets will ordinarily only indicate departments, not machines, while there will be no necessity of maintaining route sheets within the department.

The planning station in a department of a shop operating under decentralized control may maintain a planning board which is similar in almost every respect, including operation, to the central planning board already described, except that it will cover only the machines and workplaces of the one department. If such boards are maintained departmentally, then there will be little or no need for the central board. This will be replaced by some sort of progress chart which will indicate the operations to be performed, by departments, and the progress that has been made upon them. Progress charts of this kind have already been described.

Frequently in large departments there are two clerks, one representing or collecting cost data and the other devoting his time to planning and controlling the production schedule. Both of these functions are usually performed even though the volume of work may justify only

one clerk. In the event there is only one clerk, he will often report functionally both to the cost department and the planning department even though he may be directly under the supervision of the department foreman.

Under decentralized control, movement of materials between departments may be ordered by the departmental planning unit, but after consultation, usually by telephone, with the central planning force. However, each departmental unit will ordinarily have a move man under its control. Movement of material from stores to the first department in which work is to be performed will usually be ordered by the central department. If work be moved from a production department to a separate inspection cage, under decentralized control, the department planning unit will usually order the work into the inspection cage, while the ordering of the work out of the inspection cage to the next department will frequently be left to the central planning group.

There are no new planning concepts involved in decentralized control. It is only a means of making the control run more smoothly under the conditions which have been mentioned. Nominally, the foreman is usually put in charge of the departmental planning under this arrangement. Nevertheless, the planning clerk in the department, who is nominally supposed to report to the foreman, is usually given such complete control of planning by him that he is, to all purposes, wholly a representative of the central planning department in the shop. Besides correlating the work of the department with the central plans, he will make reports of progress on work under way, which will enable the central department to post any records of progress which they may maintain. In any case, he is a force working toward flexibility in planning.

CHAPTER XLIX

PRODUCTION PLANNING IN STANDARD QUANTITY MANUFACTURE

Although the same functions must be performed in planning for standard quantity manufacture as in any other types of manufacture, yet, because of the fact that the machinery is set up, and then continues to produce as long as material, power, and labor are present, actual day-to-day planning is simplified. It is in the original development of the manufacturing process and in the layout of the machinery that the greatest problems arise.[1] Since it is the automotive industry that has developed this type of production most completely, it is also that industry which has developed, to the greatest extent, production methods suited to the process.

An example of standard quantity manufacture.[2] Any one of the major automobile manufacturing plants or one of their assembly plants would serve as an excellent example of planning control in mass production of a standardized product. The automobile industry has led the field in plant layout, conveyorization, flexibility in certain details of a standard product, the use of special purpose mass production equipment, and the application of Taylor's principle of high wages and low unit costs. Other industries, such as the farm implement manufacturers, steel manufacturers, electrical manufacturers, clothing manufacturers, etc., have adapted the mass production techniques of the automobile industry to the individual requirements of their respective industries.

Figure 176 does not represent a single automobile manufacturer's method of control and synchronized time schedule but is a composite of several of them. Individual plants may exceed the remarkable performance portrayed in this chart. For instance, the modern Plymouth Assembly Plant of the Chrysler Corporation is geared to produce 2000 finished cars per day at the rate of 3 per minute. The key to the entire production planning control is synchronized timing not only of each of the 2000 or more distinguishable units composed of some 15,000 pieces, but also of the raw materials used in these pieces and assemblies. The Plymouth Plant is equipped to handle more than 180 freight cars daily in and out of their sidings in addition to more than 100 motor trucks that bring materials from near-by sources of supply. Many of these

[1] See Fig. 27, Ch. IX, p. 134.

[2] Adapted with permission from *Automobile Facts*, Vol. II, No. 4, December, 1939.

assemblies go to the assembly line direct from their outside supplier and must meet a timed schedule the same as the parts produced by the plant itself.

The completed automobile is largely an assembly of a series of sub-assemblies put together in an orderly sequence. The frame comes to the final assembly line from another department or even from a plant miles away. So it is with the body, steering wheel, wheels, fenders, tires, engine, etc. As the frame proceeds down the assembly line, brackets are attached. These are followed in turn by the front axle assembly; rear springs; rear shock absorbers; real axle assembly, including brakes, drive shaft, etc.; fuel tank; power plant; steering gear; exhaust line; hand brake; hydraulic brakes; wheel assemblies, including tires; radiator; battery; body (see Fig. 177); fenders, front end, and running boards; hood; headlights; bumpers; hub-caps; and floor mats. Before reaching the end of the assembly line, gasoline is placed in the tank and the car is driven off the line under its own power. Each of these assemblies was started in time to be ready when needed on the assembly line. Some of the material that went into the assemblies was produced months ahead of actual use in the final product. Orders are anticipated so that malleable iron parts are cast as long as thirty days in advance, gear blanks machined, upholstery woven and dyed, tires, tubes, and rims manufactured, etc., so that a dealer's order for a particular model with a specified color and trim combination may be filled in a reasonably short time, usually from one to two weeks.

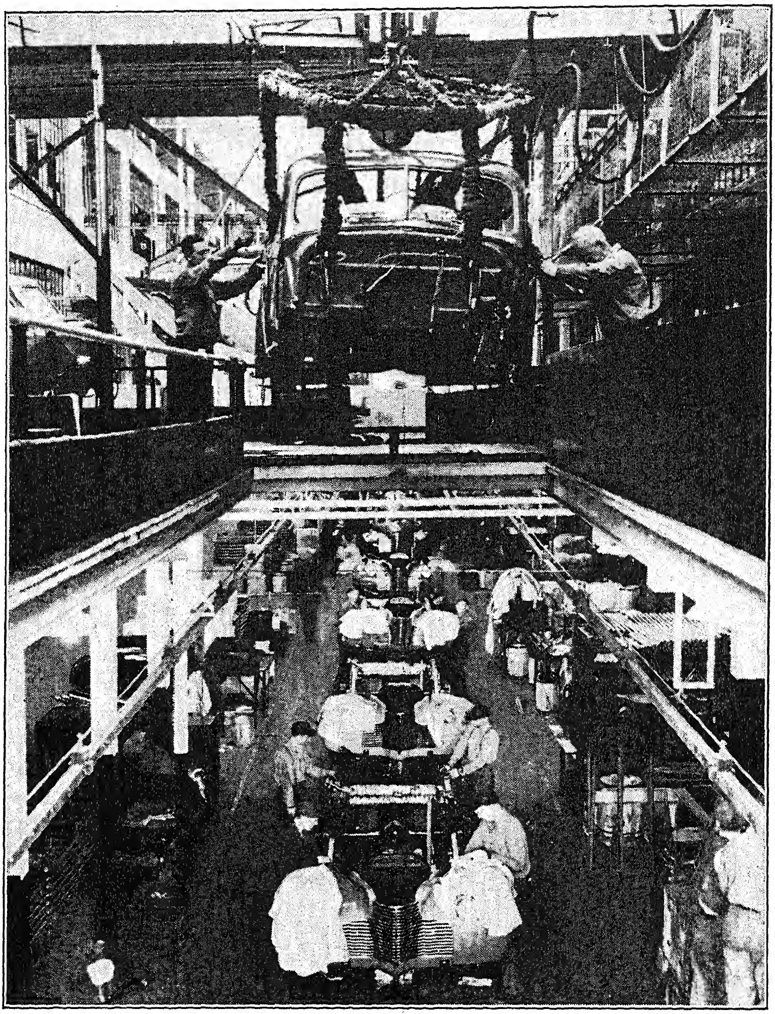
Scheduling quantity production. The master schedule in such manufacturing is very simple, merely a sheet of paper showing the number of each type of automobile to be made in a given month or months. This master schedule is broken up into components by the production department. If 1000 automobiles are to be made in a given month, 1000 crankshafts will be needed, but there will be 5000 wheels needed.[3] Presumably there will be sufficient of each type of equipment in the factory to make the relative numbers of each part that is to be made within the plant. The planning department must see that the schedule does not call for larger amounts than the capacity of the equipment or assembly lines. If this should happen, the general management must decide whether additional capital is to be invested in equipment to meet the increased load, or whether the emergency is to be met by overtime, or letting out more parts to be made on the outside.

The purchasing department and the materials department are given copies of the schedule broken down into components. That is the necessary authority to purchase in quantities sufficient to cover the schedule. No maximum, minimum, nor apportioned amount is neces-

[3] Most of the present models have a spare wheel.

sary, as each series of purchases will just cover a particular production schedule, with proper allowance for material spoiled in manufacture.

The schedule is broken up according to the time that components and operations on these must be started, in order that assembly lines



Courtesy "Automobile Facts"

FIG. 177. Lowering the Body to Meet the Chassis at the Chevrolet Automobile Plant.

may have all components as needed. Daily quotas for each component are then set, these bearing a direct relation to the master schedule. In many plants, deliveries are arranged so that only two or three days' supply of any purchased material or component will be on hand at a

time. Manufacturing operations on components are laid out in the same manner. This reduces to a minimum the amount of capital tied up in materials, and it also reduces the amount of storage space needed.

Time distribution schedule for automobile body manufacturing. Changes in the design of the product and changes in the processing frequently require a revision in manufacturing time, readjustment in plant layout, and at times results in excess manufacturing space or may require additional floor space. The introduction of the all steel body has almost eliminated the woodworking departments, the large dry kilns, and the large lumber storage space. The substitution of steel for wood has reduced the length of the production cycle. In 1928 the length of time ahead of body delivery date required to authorize the ordering of lumber was 158 working days. This was 30 days longer than any other single item used in the body. At present approximately 11 hours are required for the final assembly of a body, that is, from the time it first takes form in the "set-up buck" until it leaves the paint and trim departments. This total assembly time does not include the time involved in sub-assembly operations. The following time distribution schedule is a composite of the times required by a large automobile body manufacturer for his current production. It is representative not of a single model but of the entire line.

TABLE 16

TIME DISTRIBUTION SCHEDULE FOR AUTOMOBILE BODY MATERIAL

Material	Place order with supplier (days)	Release of detail specifications (days)	Delivery to plant prior to use (days)	Processing time prior to assembly (days)
Sheet steel	90	With order	30	10–30*
Malleable castings.	42	With order	10–30‡	3
Upholstery.......	90–180§	60	30	10–30†
Lacquer..	30	14	10–30‡	0
Glass.............	60	With order	10–30‡	0

* Fabrication of the steel panels used in the construction of a uni-steel turret top body requires from 10 to 30 days, depending upon transportation facilities and the proximity of the manufacturing and the assembly plants. One complete set of stampings demands the use of some 600 dies, which are rotated in the presses. Thirty days are required to complete a set of body stampings due to the use of similar die cycles in press room operations.

† Preparation of the interior trim for a single body takes from 10 to 30 days of elapsed time. The material must be inspected, graded, matched, cut and sewed.

‡ The bank of material carried in stock ahead of processing depends largely upon the distance of the source of supply from the plant using the material. Lacquer and glass come ready for use and require no lag between the time of receipt and use.

§ The variation in time is dependent upon the general situation in the wool market.

An illustration of planned control in a shipping department. Shipping in large scale manufacturing becomes a complicated problem in

control especially when the product is shipped extensively in less than carload lots. In the meat-packing industry many dealers are not equipped to handle carload shipments. The large packer is faced with two problems that require close control. One is that excess labor and equipment will be needed if shipments are not synchronized with a definite schedule. The second problem is one of service. The dealers want delivery to coincide with their sales needs. Increased use of the practice of "mixed car shipments"[4] caused a situation to arise at a Mid-Western meat-packing plant that the management thought could be solved only by increasing its shipping facilities. An outside firm of consultants was called in to make a survey. On careful analysis this firm found the actual status of shipping for a given day to be that portrayed by Fig. 178. Inspection of this chart shows that the last car was loaded at 8 P.M. and that all six loading stations were used.

The consultants found that the method of sending orders to the shipping department and the method of filling these orders was antiquated. A careful system of planned scheduling of orders was worked out and applied to the same orders as that illustrated in Fig. 178. The new schedule is portrayed by Fig. 179. An inspection of the scheduled shipments shows that the last car was to be loaded by 6 P.M. and that only three of the loading stations were used. The scheduled system of shipping eliminated the necessity of a proposed expenditure of $1,500,000 for new shipping facilities and gave better service to the customers. After more than four years of actual service the planned control of shipments is still working satisfactorily and there has been no further consideration to enlarging the shipping facilities. As a matter of fact, the new program showed that excess capacity existed.

Job departments in quantity production plants. There are always certain operations or parts which cannot be controlled according to this method. For instance, on small punch-press articles, it may be possible to produce a month's requirements in a few hours. Such items are turned out by job-shop departments, which are diversified manufacturing sections within the standard, quantity-production plant. There operations may be handled in accordance with methods already described.

Material control. In considering purchasing it was pointed out that in quantity-production plants, delivery dates for a given order may extend over some time, and that consequently but little paper-work is necessary in handling stores in such plants. Follow-up of purchasing is responsible for seeing that materials are delivered in time to meet the requirements of schedules.

Professor Charles B. Gordy of the University of Michigan has

[4] See Fred E. Clark, *Principles of Marketing*, The Macmillan Company, New York, 1933, pp. 336-340.

pointed out that, "Stock records can be arranged in a manner that will facilitate greatly the follow-up. The issuing of a requisition for each batch of material leaving the storeroom results in too much clerical detail, in the case of the larger part of material used in assembling an automobile. Material can be charged from the stock records on the basis of the number of cars or units produced during a week or month, by breaking up this amount of production into the component parts of a complete unit. Certain companies have gone a step farther, and disburse stock on the basis of the manufacturing schedule in advance of building. This gives the follow-up department a knowledge of any shortage existing at the beginning of the month and gives sufficient time in which to expedite deliveries." [5]

The layout of such plants should be so arranged that there need be no finished-parts storage. The equipment should be balanced so that there will be exactly enough parts produced daily for assembly requirements, and these parts should have the last operation performed on them so that they are available immediately for assembly, being finished either adjacent to the point of an assembly line at which they are used or near a conveyor which takes them to that point. Of course, this ideal cannot be reached exactly, and it is necessary to have some finished parts banked near the point of usage to guard against temporary breakdowns.

Planning department functions in quantity manufacture. It is evident that the functions of the planning department of a quantity-production plant will differ considerably from those of a planning department in diversified manufacture. In quantity production its functions are mainly to work up the schedules, to tell the various department foremen how many units they will be required to make in a specified time, and to maintain records to insure that the schedules are being followed.

As in the case of any planning department, time study and material control may not come under its direction. It is not necessary, owing to direct line layout, to control work between machines to any considerable degree. It is obvious that, because of the similarity of the work put through the plant for a long period of time, the planning department is only breaking down into units the major business budget. However, with the advent of many color combinations in the automobile industry, their planning—especially the dispatching function—has become immeasurably more complicated, even though the individual assemblies are still relatively simple to control.

Fig. 180 illustrates the functioning of a dispatcher's office and the intricacies of control in the Plymouth Plant. Through the telautograph and the track sheet instructions are given to some sixty key points

[5] *The Journal* of the Society of Automotive Engineers, Vol. XVI, No. 6, p. 607.

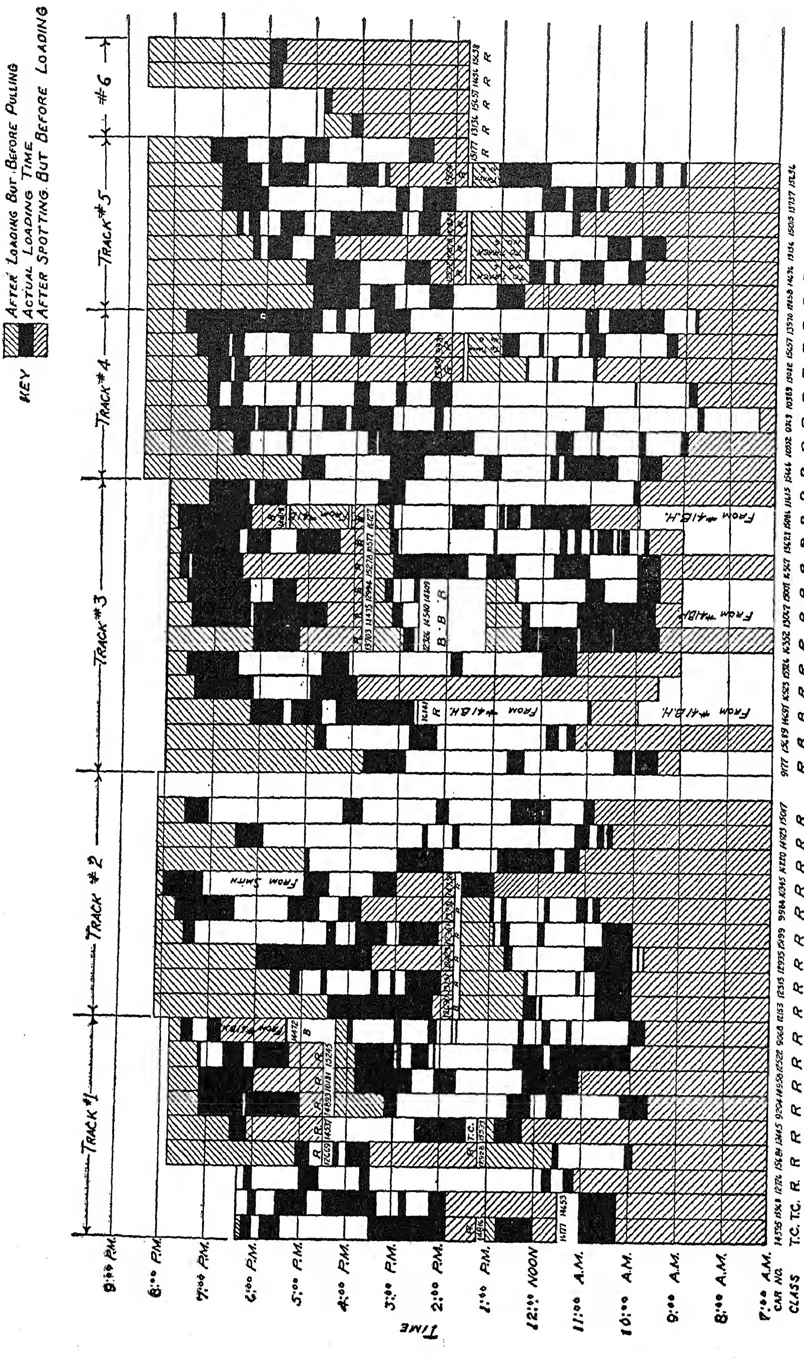


FIG. 178. Chart Showing Actual Time Used in Loading Cars by a Large Meat-packing Firm Prior to Controlled Scheduling.

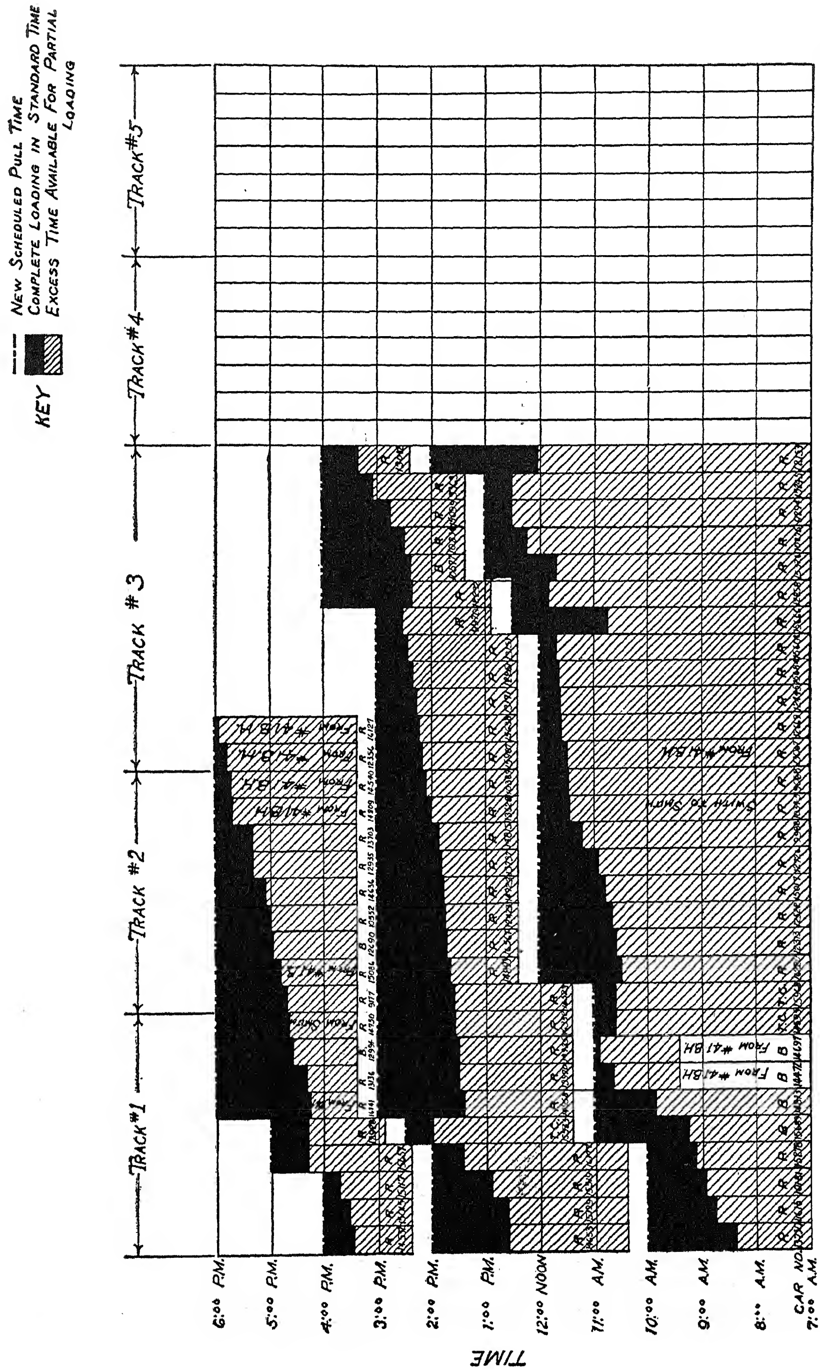


FIG. 179. Chart Showing Actual Time Used in Loading Cars by the Same Meat-packing Firm After Controlled Scheduling. Compare with Fig. 178.

scattered throughout the plant. For each car built specific instructions regarding color, type of upholstery, and the kind of equipment are issued on a "track sheet." From this track sheet each department interested can tell the exact order in which certain chassis are moving down the assembly line and is thus in a position to load its conveyor with the proper parts to go with each particular car. When a body is released

Courtesy The Chrysler Corporation.

FIG. 180. Dispatcher's Office, Plymouth Motor Car Co., Detroit.

to the body finishing and inspection line this is a signal to order all other parts to match the body, and instructions are issued accordingly. It is said that only once in eleven years has the wrong-colored chassis arrived at the "body drop' (see Fig. 177) in the Plymouth Plant.

Only a few types of manufacture can be put on a quantity basis, such as that just described. It will be evident that such a basis is profitable, not only because of lowered direct production cost, but because the costs of production control, when considering the volume involved, are much less than in diversified manufacture.

CHAPTER L

GOVERNMENTAL INFLUENCES ON MANAGEMENT

Social philosophies. The philosophies of a people regarding the rights of individuals and groups in their efforts to earn a living, to enjoy the privileges of social intercourse, to follow the traditions of their church or dictates of their consciences in matters of religion and the power of government to restrict or interfere with individuals or groups in these normal relationships is by no means fixed either as to time or geographical area. The classical economist emphasized the *laissez-faire* philosophy of the individual and free competition with a minimum of governmental interference and control. This group recognized the fact, however, that certain functions might well be more effectively and advantageously performed by the state, such as the maintenance of roads, postal systems, national protection, etc. This basic philosophy, with slight modifications to meet changing conditions, has dominated the actions of businessmen and to a large extent governmental action in America until recently. Even at the present time this is in all probability the dominant philosophy; although it must be admitted that large groups seem to feel that the individual is incapable of caring for himself and that it is the responsibility of the state to plan for him. In America these advocates of national planning do so within the framework of democracy.

At the other extreme from democracy are found the totalitarian states such as Russia, Germany, and Italy, where the individual is of minor significance and the state welfare paramount. The method of approach to state totalitarianism differs considerably in Russia from that in Germany, but the result as far as individual liberty is concerned, when viewed from the American standard, is essentially the same. Russia emphasizes class consciousness and allegedly has arrived at state totalitarianism the democratic way. The fascist's claim is that classes, even though unequal in number, are given equal voice in determining the control of the state. In both Germany and Italy the ownership of property is still mainly in the hands of individuals even though its use is prescribed largely by the state, while the Russian state claims all property. It should be noted that the Russian philosophy in action has been greatly modified during the past twenty years; yet adherence is still

given to the original tenets. Fascism, being less radical in its break with the traditions of the people embracing it, has undergone less change than Communism during the period of control. Democracy has tended in the past to lean toward decentralization not only regarding the source of its authority but also regarding its carrying out of the authority delegated, while the totalitarian states place the authority in a strong central state.

What do governmental philosophies have to do with business management? The cultural pattern of a people is both influenced by and influences the form of government. The democratic way emphasizes individual responsibility and confers authority equal to the responsibility. This method elicits the collective thought and effort of many while in centralized control both authority and responsibility for the over-all action rest on the central group. As we have seen in industry, centralized planning and control work very successfully in a small enterprise, but decrease in efficiency with the growth in size and distances in large enterprises. In strong totalitarian states individual initiative is largely restricted by the state save in work for the state, and even in this work for the state, the direction is indicated or even dictated by the state. It is very doubtful whether individuals en masse can ever be motivated to exert themselves to their capacities for the love of the state. Even Russia found that maximum production could be secured from its workers only when they were paid in proportion to their output and now pays a high percentage of her wage-earners on the basis of results.[1] In democracies strong centralized control has not as yet been undertaken; yet this philosophy has its advocates just as certain industrial enterprises are organized on this basis. In recent years the authority of the federal government has been greatly enlarged by extending the interpretation of the meaning of "interstate commerce" to include activities undreamed of in former years. These restrictions laid down by the federal government have definitely influenced management's activities. It is conceivable that the steps taken thus far may promote the general welfare without appreciably diminishing individual initiative. Just where this trend will lead no one knows. It is important to recognize a definite shift in the basic philosophy and strive to preserve the old worth-while values while we are acquiring new ones. Management, regardless of its advocacy or opposition to the changing order, must of necessity modify its techniques to conform to the new regulations. A few of these influences and changes will be discussed below.

Taxes. The industrialist fully recognizes that governmental agencies render valuable services to production. Being cost conscious he realizes

[1] See Z. Clark Dickinson, *Compensating Industrial Effort*, The Ronald Press Company, New York, 1937, p. 84.

that such services as fire and police protection, postal service, roads and waterways, national protection, aids in foreign trade, banking aids, patent regulations, standards of weights and measures, inspection of food products, etc., must be paid for, and that it is perfectly reasonable that individuals benefiting from these services should pay for them. Taxation is the accepted method of raising funds to pay for governmental services. Taxes may be looked upon as the government's share in the national goods and services produced. Many students of governmental relationships like to think of the payment of taxes as a payment for services rendered currently or in the past.[2] There may be room for honest differences of opinion as to what constitutes a legitimate service to be rendered by government. This is the place where basic philosophies clash. Of one thing there is little division of opinion; namely, goods and services disbursed by a governmental agency are not available to be distributed by those who produce these goods and services. For instance, according to the Annual Report of the General Motors Corporation for the operating year of 1938, $450 were paid in taxes for each of its 163,972 employees, while the tax paid per employee for 1935 was $334. This may be the most effective method of distributing the income, but it is self-evident that such a distribution makes it impossible for management to distribute any portion of that amount to the employees, stockholders, or to apply it to a reduction of the selling price to the consumer. The trend in the situation creates a new problem for management in its relation as a trustee for the stockholders, employer of workers, and the consumers of its product. The following table indicates the trend of the total funds collected by governmental agencies in the United States over a period of twelve years:

Year	Taxes to National Income	Year	Taxes to National Income
1926	11.7%	1933	16 8%
1927	12 2	1934	17.0
1928	12 3	1935	17.3
1929	12.3	1936	16 1
1930	14 2	1937*	17.7
1931	15.4	1938*	22.0
1932	17.4		

* Preliminary.

Source: Adapted from the National City Bank of New York's Monthly Letter; August 1939.

[2] In recent years there have appeared certain advocates of taxing for purposes other than the raising of revenue, that is the taxing of individuals who fail to conform to certain prescribed regulations. The protective tariff of course, has long been such a tax, yet it is no tax at all if it really protects. One might argue that if the individual conforms to the regulation he will not be taxed.

The 1938 tax was equivalent to $105 per capita of population and $317 for each employed person. It should be further observed that not only were the funds thus raised by taxation disbursed by the various governmental agencies, but during the period from 1930 on, the national debt increased somewhat more than 20 billion dollars, the various agencies distributing considerably more than is indicated by the amount raised by taxation. These data are presented neither as a matter of approval nor criticism, but merely to point to some of the managerial problems inherent in the changing social and economic situation. If current governmental commitments are to be met and the debt paid, there is in the near future little likelihood of any great reduction in the share of the national income that is to be routed through the hands of governmental agencies. This will of necessity affect in some degree the price of certain goods as well as the demand for these and other goods,[3] the wages received by the employees,[4] and the return to the owners of business.

Local governmental agencies. In achieving the immediate objectives of an enterprise local governmental regulations are often more vital than the state or national ones although they are often directly influenced by these higher authorities. Police and fire protection are two of the most pertinent ones. The importance of police protection is seldom fully appreciated until it fails to function as was thought by many to have been the case in the Michigan sit-down strikes during 1937. Adequate fire protection is measurable in terms of reduced premiums paid for insurance. Health and sanitary regulations are often local, but they more frequently are matters of state control. The local authorities, however, have much to do with the enforcement of these regulations. Requirements for smoke control and waste disposition are often established locally. At times local taxes may become excessive and create a situation that causes the enterprise to seek another location where taxes are more favorable. Such a move would usually give only a short run advantage. An enterprise that has to look to special tax concessions to survive competition is in an unhealthy condition. Most business enterprises meet their tax obligations promptly. Several large companies during the depression of 1933 advanced the local government funds on its tax bill due the following year in order to aid in the continuity of public service. This move was both good business and sound public relations.

[3] The demand for some goods, particularly the necessities, has probably been increased during recent years and may also continue somewhat higher by distributing a larger share of the national income through governmental agencies.

[4] Employees as used here includes hired managers as well as workers in the lower levels.

One of the responsibilities of management is to direct the activities of its enterprise so that it will be looked upon as a desirable citizen. This requires careful consideration of long-run public relations. It is not always wise to demand the full measure of legal rights when the community sentiment runs to the contrary. Business management is more than technical and financial direction. It requires increasing attention to the social and community relationships.

State regulation of business. Until recently the respective state governments have been the most powerful agencies influencing business. In many states this position still holds, yet recent social security and labor legislations, supported it is true in many instances by state legislation that conforms with the federal law in order to secure a federal rebate in taxes collected, bulk large in the regulatory controls. Corporations are legal creatures of the state and must conform to state regulations to conduct their affairs. Various and sundry reports are requested of business enterprises by the state. These reports form the basis of taxing as well as information upon which to base intelligent controls. The states have unemployment insurance as well as workmen's compensation insurance. The state is undoubtedly a logical unit for the control of these functions. State safety laws designed to preserve the health of the workers and protect them from accidents must be complied with. Minimum wage and maximum hours regulations prevail in some jurisdictions for women and children and in others for all workers. Several states have laws governing strikes, labor injunctions, and various other labor relations. Many of these regulations are designed to promote the general welfare, health, and safety of the people. A few may have an economic bias to give one group an advantage by law that it could not in the short run secure by competition. Regardless of the desirability of a particular law, as long as it does not violate constitutional rights, the business manager must take them into consideration in planning his business program. A goodly number of these laws have come into existence as a result of the worker's struggle for security and in many instances a failure of management to live up to its obligations and opportunities to practice an enlightened labor relations and public relations policy. Much of this regulatory legislation is desirable in principle even though its administration has at times not lived up to the hopes of its intelligent supporters among all groups. In many instances the business enterprise goes beyond the minimum requirements of the law. If business is to avoid further regulation by statute, management must learn to operate on a basis at least equal to or somewhat beyond the social expectations of the group. Self-regulation freely participated in by all interested parties is in many respects to be preferred to regulation by

law. Co-operative effort will tend to carry industry and the society of which it is an integral part to a higher level than regulation striving to achieve the same end but enforced by a higher authority.[5]

By no means have all state regulations been the result of pressure from political or social groups. Some have been promoted by pressure groups of business interests. Price maintenance certainly was not advocated by the consumers. Regulation of crude oil production has both a political and business interest background. Regulation of commercial transportation on the highways has long been advocated by railroad interests. Uniform Sales Acts have been advocated by organized sales groups and the legal profession. Farm interests are by no means free from the charge of promoting special regulations in their favor. In at least one state they have sought legislation requiring all public-eating establishments to serve cheese with each meal. About twenty states prohibit the use of oleomargarine in state institutions. Some state regulations of milk are designed to give advantage to the producers within the state. Under the guise of the state police powers, regulations covering many phases of business activities have grown to the place where they serve in many instances as a definite threat to the freedom of trade between states.[6] In the long-run most of these selfish state regulations will work to the detriment of the very interests they seek to protect.

Federal regulations influencing management. The original federal regulations grew largely out of the revenue securing function of the federal government. The constitution grants the federal government exclusive jurisdiction over interstate and foreign commerce. The Civil War did not entirely settle the question of states rights. There has been a gradual enlargement of the sphere of the central government by expanding the range of activities included in the interpretation of what constitutes interstate commerce. For a long time the manufacture of goods was not to be within the meaning of interstate commerce.[7] The more recent decisions of the Supreme Court in connection with the National Labor Relations Act seem definitely to include manufactur-

[5] This statement is true even though the higher authority is an expression of the uncoerced will of the majority determined in a democratic manner. A majority may take unfair advantage of a minority. Of course, the reverse is also true Real industrial and political democracy is the rule of the majority with due regard for the rights of the minority.

[6] See *Barriers to Internal Trade in Farm Products,* Bureau of Agricultural Economics, Department of Agriculture, March 1939, also *Comparative Charts of State Statutes Illustrating Barriers to Trade Between States,* Works Progress Administration, May 1939.

[7] See Hammer vs. Dagenhart, 247 U. S. 271 (1918); also Carter vs. Carter Coal Co., 298 U. S. (1935).

ing within the authority of Congress to regulate interstate commerce.[8] If the present trend be continued most business activities other than the strictly local ones will come within the range of Congressional control. Time alone will tell just what the inclusiveness will be. Popular opinion and desire will usually find a way to confer regulatory powers upon the central government if it seems advantageous to do so.

A few of the federal regulations definitely influencing management are the National Labor Relations Act, the entire group under the Social Security Act, acts regulating the coal industry, acts regulating agricultural production and farm credit, pure food and drug regulations, fair trade practices, price maintenance regulations, a series of regulations covering rail and truck transportation, fair labor standards or minimum wage and maximum hours regulations, regulation of securities issue and exchange, import quotas on such items as sugar, patent controls, etc. It is not within the scope of this book to explore the desirability of restrictions imposed by these many federal controls. It is sufficient to point out the fact that the business man today must chart his course in such a manner that he will operate within the rules and regulations prescribed for his particular industry. He must be prepared to think in terms of values and rights undreamed of by his predecessors.

Probably the hardest task that has been imposed upon management by the various governmental regulations has been the adjustments necessary to its thought processes. New concepts have been developing in regard to property rights in the business enterprise. No longer is the employer free to select or retain only the particular employees he desires, especially in those industries where the union is strong enough to force a closed shop and reserves the right to select its own members. Fortunately, such rigidities are not common in American industry as yet but they do exist. The right to discharge for cause other than union affiliation is still reserved to management; however, it must be prepared to defend its actions should the discharged employee claim that his discharge was the result of his union activity. Herein lies managements most difficult adjustment. Traditionally management has not had to account to some outside agency for the discharge of its responsibility in the maintenance of discipline or efficiency. (It must be admitted that at times management has misused its prerogatives.) Today these rights still remain, but management must be in a position to defend its acts before a governmental agency when the aggrieved employee claims discrimination because of his union affiliation. These changing conditions have forced management to re-evaluate many of its procedures, tech-

[8] See *National Labor Relations Board vs. Jones and Laughlin Steel Corporation,* 301, U. S. 1 (1937); also *National Labor Relations Board vs. Friedman—Harry Marks Clothing Co.,* 301 U. S. 58 (1937).

niques, objectives, and philosophies—a task which many men in authority have been poorly equipped to perform. All of this points to certain defects in the training of our executives in the past.

For many years the major managerial responsibilities were problems of finance, merchandising, product design, plant layout, processing, and worker efficiency in terms of productivity per work hour. As a group our industrial leaders have been adequately trained to meet these responsibilities and must continue to be. On the other hand, they have been inadequately trained in the underlying philosophies of social behavior, individual and group objectives, social backgrounds, racial and religious characteristics, etc. The critic may say that a man is not employed because of any of these factors, and this is true, but it does not follow that these items do not influence the "worker in his work situation" after he is employed. The training of managers in the future will be incomplete if it does not include the essentials of his previous technical training. On the other hand, it should be expanded to include psychology, sociology, economics, industrial relations, and governmental institutions. Functional specialists have already appeared in these fields yet their use will most probably remain purely functional. Real effectiveness in these fields is the result of daily relationships of the workers in their work situations This can be achieved only by increasing the understanding and appreciation of the great group of supervisors. It is not an insurmountable task. The supervisors will follow the enlightened leadership of responsible management.

PART VIII

APPENDIX

APPENDIX A

DETAILS OF STANDARD NOMENCLATURE

The requirements of daily operating conditions demand the application of a standard nomenclature to the items that have been arranged through the development of a classification. Something more accurate, shorter, more concise, and less ambiguous than names or words is necessary. Such requirements are met through the use of symbols.

Symbolization. Symbolization is the assignment to all classified items of a series of related characters, in such a manner as to aid in the recognition of the item and definitely to fix its identity separately from all other items in all phases of the business. The completed set of symbols comprises a system of standard nomenclature for a business.

There have been a number of effective methods devised for the development of standard nomenclature, some of which are in common use. The two main methods utilize, respectively, as the base of the symbol system, numbers and letters. Both methods frequently use the main device of the other to aid in the expression of particular conditions. Methods utilizing numbers may be again divided into straight numerical systems, and Dewey-Decimal Systems which express relationships by the positions of numerals to the left or right of the decimal point. Both are developed along essentially the same lines. Methods that are based primarily on the use of letters are ordinarily called mnemonic, because they are designed with the primary idea of having the symbol easily remembered.

Compromise is the basis of the art of working out of standard nomenclature. Deviations from a strictly logical series of symbols are often necessary to preserve a logical classification, which is more important. Effective symbols should be as short as possible, should be absolutely definite, so that one symbol can mean one and only one thing, and should be as mnemonic as possible.

Numerical symbols. The numerical system of symbols is used in a large number of businesses. With this system, the symbol may consist of one or more separate numbers. For instance, expense items are frequently designated by indicating the number of the unit of the business incurring the expense, followed

by the symbol representing the expense. Whenever this system is utilized, a block of consecutive numbers is usually assigned to each general class into which the activities of the business are divided. The advantages of the numerical system are:

1. Its seeming simplicity at first glance.
2. Its ready adaptability to use in connection with tabulating machines.
3. Its particular simplicity when only accounts are classified.

This last factor is the cause of the almost universal adoption of the numerical system when only accounts are classified. The disadvantages of the numerical system, compared to the use of letters (usually termed the mnemonic system) when combined into a system alleged to be memory-aiding are the following:

1. It is difficult to associate the symbol with the item classified, which factor is particularly important in items of stores, product, etc.

2. Each position in the symbol only gives the possibility of 10 class divisions, while there are 22 in the case of letters.

3. Because of the use of numbers for all purposes, sizes cannot be readily shown in the symbol.

4. In stores or production control work, the symbols tend to become extremely lengthy.

5. It is difficult, if not impossible, to develop a series of symbols to cover all the items in the business without repetitive numbers. These disadvantages are somewhat modified in case of the manufacture of standard product, where the number of items to be classified is somewhat less.

The Dewey-Decimal System, while essentially the same as a numerical system, is not so well adapted to business as to library work, because of the likelihood of misplacing the decimal point that is used.

The following is an extract from an example of the development of a numerical nomenclature:

Department Numbers (1-199)

Executive Department (1-9)

1. President's Office
2. Vice President's Office
3. Treasurer's Office
4. Secretary's Office

Comptroller's Division (10-19)

11. Credit Department
12. Accounts Payable Section

Sales Division (20-29)

21. Domestic Sales Department
22. Export Sales Department
23. Sales Promotion Department

General Office (40-49)

41. Stenographic Section
42. Mail Section

Maintenance Department (70-79)

71. Machinery Section
72. Equipment Section

Production Control Department (100-109)

101. Planning Department
102. Standards and Methods Department

ASSET ACCOUNTS (200-299)

Plant (200-224)

201 Land
202. Buildings

Equipment (225-234)

226. Machines
227. Motors

Current Assets (260-271)

261. Cash-General Funds
262. Cash-Cashier's Fund

Investments (272-279)

273. Sinking Funds.
274. Contingent Funds

LIABILITY ACCOUNTS (300-399)

Funded Debt (300-309)

301. Bonds
302 Coupon Notes Payable

332. Capital Stock Premium (Subscribed)

Capital Stock (350-359)

351. Capital Stock, Common
352. Capital Stock, Preferred

REVENUE ACCOUNTS (400-499)

401. Profit and Loss
402. Manufacturing
403. Sales

EXPENSES (500-)

501. Salaries—Executives
502. Salaries—Clerical
503 Commissions
504 Retainers—Premiums, Bonuses
511. Traveling
512. Entertaining
513. Miscellaneous Labor Cost
514. Janitor Service

In the utilization of this classification, departmental expense symbols are formed in the way that the following examples indicate:

23502—Sales Promotion Department Clerical Salaries
23511—Sales Promotion Department Traveling Expenses
101504—Production Control Department Bonuses
102501—Salary, Head of Standards and Methods Department

Numerical symbolization of material is extremely common, and is especially valuable in cases of the manufacture of a few standard products for which standard materials are utilized in manufacture. In such cases, effective numerical stores symbols can be built up. Although there is nothing in the symbol itself which recalls the article referred to, nevertheless, constant association of the symbol and the article soon makes possible the prompt association of the article and the symbol name by those who daily utilize the symbols. An example of a stores classification, numerically symbolized, is not given, since it merely involves the numbering of the articles of stores and product in sequence, after they have been classified.

In plants manufacturing diverse products it is extremely difficult to build up a simple and effective series of numerical symbols for stores. Symbols soon become involved; and since they do not readily recall the article they describe, and, furthermore, usually duplicate other numerical symbols used in other phases

of the business, some form of mnemonic symbol is usually adopted. As an example of the manner in which numerical stores symbols become readily involved, the following symbol used by a paper-manufacturing plant is given: 801-2-3-0-5-16. This symbol was used to designate coupon bond paper, loft dried, second quality, glazed finish, weighing 16 pounds to a folio.

Machines are ordinarily classified by an arbitrary assignment of numbers to classes of machines and individual units within the class. The first two numbers usually indicate the class of machine and the last the machine number within the class, as shown by this example:

0501—Automatic Feed Turret Lathe, 1
0502—Automatic Feed Turret Lathe, 2
2902—Gear Cutter, 2
3601—Plain Vertical Milling Machine, 1

Some plants put department numbers in which the machine is located as first digits in the number of the machine. This is inadvisable, since when machines are moved from one department to another the symbols not only cease to have any meaning, but are confusing.

Mnemonic nomenclature. One of the best types of nomenclature yet devised, which meets all requirements in practically every case, and is of great practical value, is the system based on the use of letters with the aid of numbers, commonly called the Mnemonic System. This system was worked out by Frederick W. Taylor and his associates, and their pioneer work in nomenclature stands as the best single contribution to nomenclature work in American industry. One of the most valuable phases of this type of nomenclature is that a system can be devised to classify and symbolize every single phase and item of a business in a way that makes the nomenclature a unified whole without repetition of symbols. However, in any business, only those items for which there is need of standard nomenclature need be classified and symbolized.

This system is based on a complete and exhaustive analysis of every detail of labor, materials, and organization involved in a business. All the elements are divided into logical groups, first into broad general divisions and then into subdivisions, groups, sections, subsections, and so on. Letters are used to designate each division, subdivision, group, etc., Where possible, the letter chosen is the initial letter of the name of the item or some significant letter in the name. Numbers are used to designate dimensions, job numbers, or lot numbers, depending on their place in the symbol. Numbers are also used to designate different items within a class. If there were eight or nine kinds of plain office pencils in a storeroom, numbers would be used to designate the various kinds instead of going to the detail of adding a letter for each variety. With this last condition as an exception, letters and numbers are thus, wherever possible, suggestive of that which they represent.

Since one classification and system of nomenclature is to be provided for all items of the business, a base sheet can be drawn up indicating the first letter, or main classification, of each phase or item of the business. Such a base sheet is shown as Fig. 181. This base sheet indicates that the various activities of the

organization have been grouped under three main heads: B, Business Division (including Personnel); C, Selling Division; and D, Manufacturing Division In case some other phase of the business is made a main division, it, too, should be given, on this base sheet, a primary letter to designate it, as E, Engineering Division. A is reserved for the General Accounts of the business, X is reserved for all tools, Y for all machinery, and Z for all buildings. These last three letters may represent either the physical item or the account covering this item. No confusion can exist here because of the absolutely different usage involved. The letters from F to W, inclusive, are reserved for products, with the exception of S, which is reserved for Stores or raw material. Semi-finished material is represented by subdivisions of the product symbols, F to W. This reservation of letters will apply only to the first letter of a symbol. The letters I, O, Q, and U are never utilized in mnemonic classification, since the first three are likely to be confused with numerals and the last is likely to be confused with V.

General accounts, represented in the main classification by symbols beginning with A, may be symbolized as illustrated by the following example:

A—General Accounts

AA Revenue Accounts	AM Material Accounts
AB	AN Unfunded Debts
AC Current Assets	AP Plant Accounts

After these main subdivisions of accounts have been made, actual accounts may be symbolized by further subdividing these divisions mnemonically, or by merely adding account numbers after the two-letter symbol. Inasmuch as mnemonic symbols are utilized less for purposes of designating accounts than for any other purpose, no further examples will be given

Organization nomenclature. The following method of building up mnemonic symbols may be used in designating the various portions of the organization which have been classified. The nomenclature thus developed indicates immediately the relation of each unit of the organization to the organization as a whole. It is useful from that standpoint in the day-by-day operations of the business, as well as for expense division and distribution.

ITEM CLASSIFIED	DATA FOR CHARGING OF EXPENSES
A—GENERAL ACCOUNTS B—BUSINESS DIVISION C—SELLING DIVISION D—MANUFACTURING DIVISION E—ENGINEERING DIVISION *	General Expense ← Selling Expense ← Shop Expense ← Engineering Expense ← If both questions are answered NO then the charge must be against DEPARTMENTS
F, G, H, J, K, L, M, N, P, R — PRODUCTS S—STORES T, V, W — PRODUCTS	1ST QUESTION ← Begin Reading Is the expenditure one involving work on product to be sold? NO → ← YES Worked Materials or Product which will ultimately be sold to Customers
X—FIXTURES, TOOLS Y—MACHINERY, MOTIVE POWER Z—BUILDINGS	2ND QUESTION Does the expenditure increase the permanent value of the Plant? + 0 < YES)————(NO →

* If main division; otherwise under manufacturing.

+ Partly charged to asset accounts and partly to shop expenses.

0 Construction or addition to equipment which wholly increases permanent value of assets.

BASE SHEET FOR MNEMONIC CLASSIFICATION

Fig. 181

B—Business Division

BF Office Manager
BG
BH Cashier
BT Cost Accounting Section
BV Miscellaneous Business
BW

Office Manager's Group

BFA
BFB
BFM Mailing Unit
BFN Messenger Service

D—Manufacturing Division

DA Auxiliary Departments
DB Blacksmith Shop
DC
DM Milling Department
DN Foundry
DP Punch Press Department

Expense nomenclature. Expenses incurred may be designated by the use of one of the following symbols, placed after the symbol of the department, division, or shop responsible for the expense. If there be fear of confusing the expense symbol with a designation for the subdivision of a department, zeros may be inserted, and the expense symbol thus always appear in the fourth, or other predetermined position. Example: BFOA—Salaries, Office Manager's Office.

A Salaries, Commissions and Wages
B
C Consulting (including Legal)
M Machinery Repairs and Maintenance
N Retainer—(Premiums, Bonuses)
P Power Transmission

Where further subdivision of these expense charges would be desirable, this might be best accomplished by numerical subdivision before the letter designating the expense, as:

1A Salaries, executives
2A Salaries, clerical
3A Commissions
4A Miscellaneous Labor Cost
5A Janitor Service
6A Material Handling Labor Cost
7A Crane Operator Labor Cost
etc.

Thus, clerical salaries for the planning department would be segregated under the symbol DAP2A, and janitor service for the whole shop would be DOO5A.

Product and worked material nomenclature. The nomenclature of product and worked materials under this scheme is provided for by symbols beginning with the letters F to W inclusive, with the exception of S. Thus, in a plant manufacturing miscellaneous types of locks, the product classification might be as follows:

F
G
H
N Night Latches
P Padlocks
R

In many cases where a plant manufactures one composite product, such as an automobile, it is desirable to treat that product as two or more distinct things, such as chassis and body. The important point about setting up a workable

product classification is to visualize every group which goes into the final assembly. These groups are then broken up into divisions, sections, and subsections.

To illustrate the methods of classifying and symbolizing these groups and sections it is advisable to follow through the construction of nomenclature for one of the products enumerated above. Selecting padlocks, it is first ascertained that there are various kinds of padlocks, as follows:

PD	PR Railroad Switch Padlocks
PE	PS Steel Padlocks (Except PH)
PF	PT
PG	PV
PH Heavy-duty Padlocks	PW

The final product symbol is thus seen to be actually represented by two letters rather than one.

Selecting heavy-duty padlocks, it is found that these are manufactured by assembling in final assembly, several subassemblies, as follows (see Fig 182):

PHB Back Assembly	PHM Miscellaneous Assembly (Separate parts going into final assembly)
PHD Dog Assembly	PHT Tumbler Assembly
PHL Bolt Assembly	

The back group or assembly is composed of a number of parts, which, for convenience, may best be expressed as numerals, placed before the last letter. If the product were more complicated, and were composed of a number of subassembly sections, which were in turn assembled into the main subassembly, there might be four or five letters used, so that all these might be symbolized. In such a case, the component of the last subassembly would again be designated by numerals placed before the last letter. The back group may be designated as follows:

PH1B Back	PH4B Shackle Post
PH2B Case Stud	PH5B Dog Stud
PH3B Bolt Spring Post	PH6B Shackle Spring Post

Unless the purpose of developing such elaborate symbols is briefly considered at this point it may seem that they are unnecessarily complex Each part which goes into the final product must be made, usually by performing several operations. It must be routed through the plant and assembled with other parts to become a portion or whole of the final product. As such it must be controlled, and to be controlled it must be designated in some manner, either by a name or by a symbol. Furthermore, all parts must be stored at times, and yet be readily available when wanted. Some designation must be attached to each part, in order that it may be stored properly and designated in such a manner that it will be readily available or can be separately accounted for. The system of symbols being described, in addition to fulfilling all these requirements, readily shows the relationship of one part to another.

The worked-material symbols can be arranged to show dimensions or size of the product, so that the different varieties of similar products may be dis-

tinguished. Thus, if the product be a 2½-inch heavy-duty padlock, the symbol becomes P 2½ H. This size designation will be carried by every part going into the lock, as P 2½ H1B, back for 2½-inch heavy-duty padlock.

The worked-materials classification serves as a means of designating shop

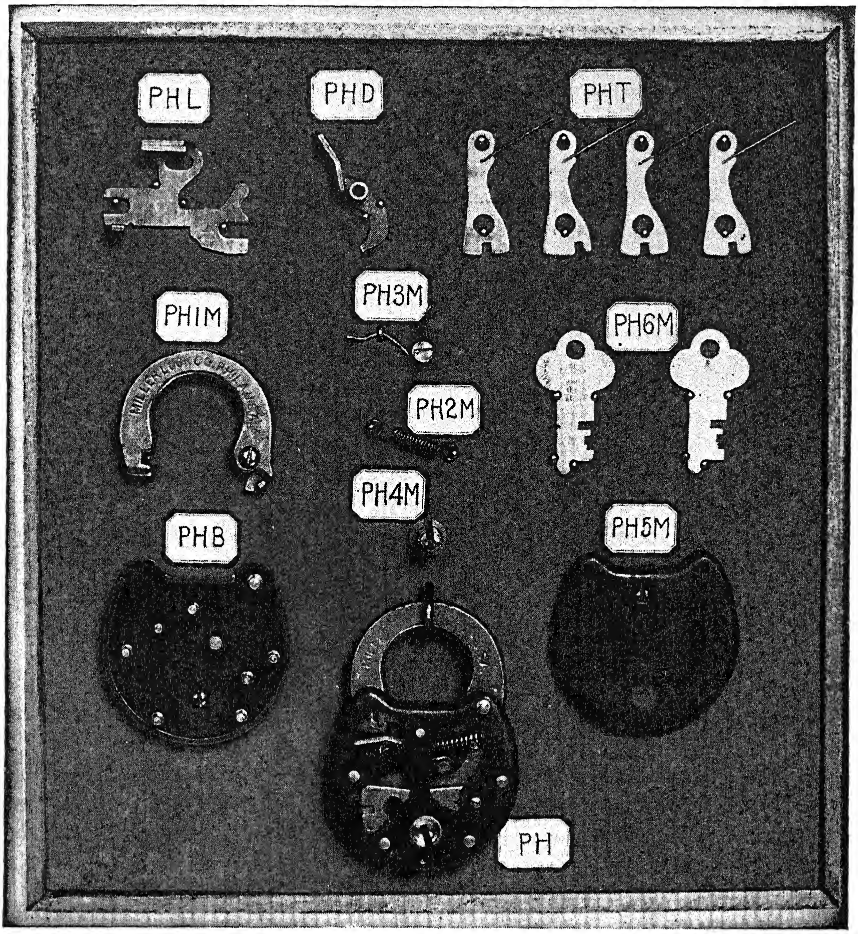


Fig. 182. A 2½-in. Heavy Duty Padlock. Finished lock (with front cut open), sub-assemblies and components entering into final assembly. (The symbols used are not those of the Miller Lock Company, manufacturers of the lock, this lock having been selected to illustrate mnemonic nomenclature and routing because of its extreme suitability.)

operations. This is accomplished by inserting the number of the operation, in the sequence which makes the piece, in front of the piece symbol. Thus 1P 2½ H1B is the first operation in the manufacture of the back for the lock. The second operation in the final assembly would be 2P 2½ H.

The worked-materials symbol may be utilized also to show the lot number of any order in process. This may be accomplished by the addition of the lot number at the end of the product or worked material symbol. Thus P 2½ H7 represents lot number 7 of 2½-inch heavy-duty padlocks

From the foregoing it becomes apparent that there are certain rules of number utilization in mnemonic symbols which have been built up on the basis of long and hard experience as follows:

1. Only operation symbols may be used as prefixes to worked-material symbols.
2. Care must be utilized in the insertion of dimension numbers before the last two places of a worked-material symbol lest these be confused with the part symbol
3. Numerical parts of the worked-material symbol may not be placed after the last letter, as this place is reserved for lot numbers.

Stores or raw-material nomenclature. It is in the classification of stores or *Purchased Materials* that the greatest possibility for variations in the methods of classifying is found. Because articles are bought from several manufacturers under different names, though the articles may be the same or similar, an additional difficulty is faced. Because of the choice of methods, and the possibility of ambiguities in the classification, it becomes essential that every detail be carefully guarded. Those articles which are special rather than standard articles of stores are not classified, but are given serial numbers prefixed by the letter "S." Thus, S1242 is an article carried in stores only temporarily, which is not a standard article of supply in the plant. This saves unnecessary work in classifying, and at the same time an automatic signal is provided to prevent the article from being carried too long. It will also help to indicate automatically when too many of a special article are on hand.

The two general methods of stores classification are:

1. Classification of materials by their nature.

2. Classification of materials by the use to which they are put or the purpose served.

The former permits a classification that is universal in its nature, and is probably necessary in very large, complex plants. When carried to its logical conclusion, it results in somewhat longer symbols than the second method. The second method may result in unnecessary duplication of symbols and some obscurity, but in plants making a standard product it is altogether desirable.

In the first method, part of the first sheet of the stores classification would be somewhat as follows:

S—Stores (Purchased Materials)

SA Stationery and office supplies
SB
SC
SD Dyestuffs
SE
SL Liquids
SM Metals
SN
SP Paper (other than stationery and printed forms)
SR Rubber and articles made chiefly therefrom
SS
SX Tools and appliances
SY Repair parts for machinery
SZ Fuels

Under this method the further classification of stores results in a narrower definition of each type of material. Thus SMZ might stand for metal fasteners. That being the case, SMZB would be bolts and SMZBH hexagonal bolts. If made of various materials, such as wrought iron, cast steel, cold-drawn steel, etc., each variety might be distinguished by a number, so that SMZB1H might mean a wrought-iron bolt The size of the bolt would be indicated by dimension numbers placed between two of the symbols (not between the last two), as SNZ⅞2B1H. This shows that the bolt is ⅞ inch in diameter and 2 inches long.

In this type of stores classification it is frequently desirable to set up, as major divisions, some types of materials which are particularly important in the business. For instance, in a textile plant operating its own dye-house an example would be found in dyestuffs, as indicated above. The nomenclature for stores under this main division might be built up as follows:

SD—Dyes

SDA Acid Dyes	SDM Mordants
SDB Basic Dyes	SDN
SDC Coupled Dyes	SDP Naphthol Dyes
SDD Developed Dyes	SDR

SDA—Acid Dyes

SDAB Acid Dyes, Blue	SDAR Acid Dyes, Red
SDAG Acid Dyes, Green	SDAV Acid Dyes, Violet

SDAB—Acid Dyes, Blue

SDA1B Acid Peacock Blue	SDA3B Alizarine Sapphire, etc.
SDA2B Alizarine Blue	

In the second method of stores classification the first sheet will have the materials grouped mainly with reference to the products on which they are used. Such classification is particularly valuable in plants manufacturing standard products, or in plants where a large proportion of the stores are intended when purchased, for use on one particular product. To illustrate:

SF	SN Stores for night latches
SG	SP Stores for padlocks

By this method the stores which are used exclusively on one of the products are classified by the same general symbol as the product itself, with the prefix S. Using the same illustration as that which was used to develop the worked-materials nomenclature, it is found that the shackle post for a heavy-duty padlock is designated as SPH4B if the piece be purchased rather than manufactured. If the piece be made in the shop and then put in the storeroom, its worked-material symbol would be PH4B. This illustrates the most valuable advantage of this method of stores classification Under it, the symbol for stores and worked materials vary only by the prefix of the letter S, provided that the part is used exclusively on one type of product.

The stores used for a variety of purposes must necessarily be classified by nature, rather than by the use to which they are put. The skeleton nomenclature for such stores would be therefore as follows:

SVA Miscellaneous stores, not otherwise classified
SVB Brass and articles made chiefly therefrom
SVC Cast iron
SVL Liquids
SVT Textiles

Mnemonic nomenclature of tools. Tools are classified in much the same manner as stores. The prefix X is usually retained in any accounts dealing with tools, as indicated in the master sheet. This prefix is ordinarily dropped when stamping the symbol on the tool or referring to the tool for shop purposes. For a metal shop, which has most need of an elaborate tool classification, the following is an effective base sheet:

XA Miscellaneous tools for special purposes not elsewhere classified.
XB Abrading Tools—All tools for filing, grinding, polishing, rubbing, scratching, scraping, lapping, etc.
XC Clamps and Holding Devices—Clamps and holding devices of all kinds including bolts and screws, except J & N.
XJ Jigs and Fixtures—Holding devices for specific purposes in connection with the product worked upon. Designed for manufacture of duplicate parts of a given product
XN Containers—Containers for holding materials, except as classified under C, J, or T.
XP Paring Tools—All tools which remove material from the surface by means of stationary tools and produce the required size through the operation of the machine, excepting L.

P—Paring Tools

PC Parting Tools
PR Round-nose Tools
PS Square-nose Tools
PT Thread Tools

PR—Round-nose Paring Tools

PRB Blunt Round-nose Tools
PRS Sharp Round-nose Tools

PRB—Blunt Round-nose Tools

PRBL Blunt Round-nose Tools, Left-hand Bent
PRBR Blunt Round-nose Tools, Right-hand Bent

Mnemonic nomenclature of machinery. Machinery, like tools, usually retains the main classification letter (Y) when its symbol is used to express an account, but drops it when used for shop purposes. Machinery may be classified either by the use to which it is put or by trade name. A portion of the sub-

divisions, if classification be by use to which machinery is put, might be as follows:

YB—Abrading Machinery—Removes material from surface by abrasion.
YE—Energy-transforming Equipment—Changes energy from one form to another without the intervention of a machine, e g , boilers and transformers
YK—Revolving Cutting Machinery—Removes material by a revolving motion, either in the tool or material, e g., lathes, boring mills.

If the classification be by trade name, which is more common, some subdivisions might be:

YB Boring Mills
YG Grinders
YL Lathes
YP Presses
YT Tumblers
YV Production centers which do not include machines

L—Lathes

LA Automatics
LE Engine Lathes
LH Hand-feed Turret Lathes
LL Low-swing Lathes
LT Threading Lathes
etc.

If there be a number of machines of the same type in the shop, each is designated by placing a number after the machine symbol, as LE7, engine lathe number 7.

Mnemonic nomenclature of buildings. Buildings may be readily classified and symbolized in some such manner as the following:

ZC Conveying Devices
ZE Building Equipment
ZF Office Space
ZM Manufacturing Space
ZP Underground Piping and Tunnels
ZR Power-house Structures
ZT Transmission Lines

Summary of mnemonic nomenclature. Although any portion of the mnemonic scheme of nomenclature can be used separately, and although it may be adapted in any desirable way, or used in conjunction with numerical nomenclature, it has been discussed above as a complete system. As such, it completely fulfills the objects that were established for standard nomenclature as follows:

1. It gives a measure for the definiteness of functions because by it the duties of individuals can be definitely codified, be they executive, clerical, or manual.
2. It provides a definiteness and correct sequence of operations by the use of the product classification in conjunction with proper routing and dispatching methods.
3. By means of the stores and product classifications, it provides for locating materials, both in the storeroom and in process, and makes easier the task of keeping a perpetual inventory of these articles because of the elimination of much writing of names that would be necessary if there were no symbols.
4. Costs are more readily obtained.

From the master sheet of the classification (Fig. 181) it has been seen how these primary elements are provided for and how, by the elaboration of the various groups, every item of expenditure is given a symbol. With the correct use of these symbols, the allocation of costs is made comparatively easy. It is not the purpose here to illustrate this point, because a more detailed knowledge of the functions and operation of the production department is needed to comprehend fully the true relation between classification and costs. Finally, the system serves as an automatic index for the filing of all "inside shop" information. If information about an operation is to be filed, it is filed by the operation symbol. The same is true of machine specifications and records, product information, cost records of products, and all other matters pertaining to shop routine. It was pointed out that the functions of individuals were classified. Thus information regarding the individual or his functions can be filed by those same symbols which designate the main classes. Stores records are filed by the stores symbols. Time-study data and blueprints are filed by the symbol of the product to which they apply.

APPENDIX B

USE OF STANDARD PRACTICE INSTRUCTIONS

THE SPARKS-WITHINGTON COMPANY
Jackson, Michigan

Organization Bulletin No. A 21*

GENERAL ORGANIZATION

Effective Wednesday, May 1, 1940, the general organization of the Sparks-Withington Company will be set forth in this bulletin and organization diagram drawing No. 295 dated April 15, 1940. Details amplifying more fully the duties of various departments have been covered by bulletins and this bulletin may be changed or amplified from time to time as subsequent organization bulletins are issued by the management.

MR. WILLIAM BROWN, *President*

Executive Head

MR. H. G. BROWN, *Vice-President and General Manager*

In general charge of all company activities; in direct charge of New Products Division, also Sales and Advertising and Production.

MR. H. M. FRENCH, *Treasurer*

Head of Central Accounting and Credits

PRODUCTION

PLANT No. 1

MR. W. J. FORBES

Vice President and Production Head of Plant No. 1, as well as supervising engineering new products and Plant 1 Sales Division.

MR. C. M. BROWN

Sales Manager for Division No. 1, directly responsible to H. G. Brown. Liaison between W. J. Forbes and H. G. Brown.

* Names and dates are ficititious; however, the organizational relationships are as submitted by the company.

Mr. L. W. French

Sales Manager and in Charge of Advertising for Division No. 2. Directly responsible to W. J. Forbes. Liaison officer between H. G. Brown and W. J. Forbes.

Mr. T. J. Green

New Products Division, directly responsible to W. J. Forbes. Liaison between W. J. Forbes and H. G Brown.

Plant No. 3

Mr. C. J. English

Direct charge of production engineering and experimental work and plant production.

Mr H. R. Wood

Sales Manager and in Charge of Advertising. In direct charge of sales, and directly responsible to H. G. Brown. Liaison officer between H. G. Brown and C. J. English.

Mr H. V. Steel

Charge of plant engineering, directly responsible to C. J. English.

Mr. H. O. McAfee

Direct Charge of Export Sales of all divisions, directly responsible to H. G. Brown.

APPENDIX C

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